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A

TREATISE

OF

AGRICULTURE.

Vol. I.

By Adam Dickson, A. M.
Minister at Dunse.

EDINBURGH:

Printed by A. Donaldson and J. Reid.

For the Author, and A. Donaldson.

Sold by A. Millar, oppoſite to Catherine Street in the Strand; R. and J. Dodsley, in Pall-mall; and J. Richardson, in Pater-noſter-row, London.

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PREFACE.

THE author of the following treatiſe had the management of a conſiderable farm for many years. He applied himſelf early to the ſtudy of agriculture; not only read almoſt all the books which this age has produced on that ſubject, but alſo frequently converſed with the moſt intelligent of the practical farmers, and wrote down ſuch obſervations as he judged important, whether made by himſelf, or by thoſe whoſe judgment and veracity he could depend upon; and, that he might more clearly diſcern the effects of the different operations and experiments, kept a journal of the work performed in the farm, along with a journal of the weather.

THE Society at Edinburgh for the improvement of arts and ſciences, ſome years ago, propoſed, as ſubjects for ſome of their prizes, diſſertations on the following ſubjects, on vegetation, on tillage, on manures, and on ſoils. Having obſerved this, he began to reduce into ſome order the

materials

materials which he had collected, with a view to preſent diſſertations on theſe ſubjects to that Society: but the diſſertations not being finiſhed in due time, he changed the form of them, and put them together into one treatiſe. When finiſhed, he put the treatiſe into the hands of ſome perſons, gentlemen, and farmers, whoſe judgment he could depend upon. They were pleaſed to approve of it, and to declare, that, in their opinion, it might be uſeful. Some of them propoſed a few alterations and additions, which were accordingly made. By the judgment of theſe perſons he was determined to make it public.

THE reader will obſerve, that in this treatiſe the author has attempted to reduce agriculture to a regular ſyſtem, and to aſcertain the principles upon which the practice of it is founded. The obſervations and experiments from which he has endeavoured to aſcertain theſe principles, are fairly related, and it will be eaſy for any perſon to ſatisfy himſelf as to their truth. The reaſons for every practice recommended

commended are given; ſo that no reader will be impoſed upon, but will have it in his power to judge, whether or not the principles laid down are true, and the practice recommended proper.

THE author, in proſecuting his ſubject, has followed a method different from thoſe who have attempted a regular ſyſtem of agriculture. Inſtead of treating of ſoils in the beginning, he has reſerved this part of the ſubject to the end, and has begun with vegetation. Perhaps ſome may think it neceſſary to aſſign the reaſons which determined him to follow this method.

As ſoil is the part of the earth by which vegetables are nouriſhed, one is apt to imagine at firſt ſight, that, in a treatiſe of agriculture, it ſhould be the firſt thing examined; but when the matter is conſidered with attention, it will appear obvious, that it is impoſſible to treat properly of ſoils without treating firſt of vegetation. Without knowing any thing of vegetation, we may indeed make a diſtinction in ſoils, find out the qualities of each, and the principles of which they are compounded; but without knowing the methods by which vegetation is promoted, it is impoſſible to determine whether the qualities of ſoil are good or bad, what kind of ſoils are moſt valuable, what are the defects of any of them, and how theſe defects may be remedied. Dr Home, in his treatiſe, begins with ſoils; and any perſon that reads with attention what he has wrote, will be convinced of the impropriety of beginning with this part of the ſubject. Though he mentions very few things beſides the properties of the different ſoils, and the experiments he made upon them; yet in thoſe few things which he mentions, he ſuppoſes, that there are ſome vegetables that require oil to nouriſh them [*], that ſand contains few nutritious principles, and that fermentation produces theſe [†]; that clay is not richly ſtored with vegetable food; that woollen rags contain a great quantity of mucilaginous juice, which ſerves to nouriſh plants; and that moſs is a good manure, becauſe it contains more oil than any other vegetable *. Now, all theſe ſuppoſe, that we are already acquainted with the principles of vegetation; and indeed it is not poſſible to treat properly of ſoils without a knowledge of theſe.

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[*] p. 20. [†] p. 22.

It will not be improper in this place to lay before the reader a plan of the treatiſe. By keeping this plan in his view, he will better underſtand the ſubject, and ſee how the different parts of it are connected together.

The treatiſe is divided into four books.

In book I. the author treats of vegetation. He explains the different ways by which vegetation is promoted; mentions the impediments to it; and points out the proper methods of removing theſe impediments.

He attempts to ſhow, that there are different ways by which vegetation is

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* p. 23.

promoted; that it is promoted by communicating the food of plants to the earth, by enlarging their paſture, and by diſſolving the vegetable food in the earth, that is in an uſeleſs or hurtful ſtate.

He inquires into the nature of the vegetable food, and attempts to ſhow, that it is compounded of ſeveral ingredients; that it exiſts in the earth, in water, in the atmoſphere, and in all vegetable and animal ſubſtances; that it obſerves a conſtant rotation, is communicated to the atmoſphere by corruption, and returns to enrich the earth in dew, rain, and ſnow. He ſhews, that vegetable food may be added to any particular ſpot of earth; that all ſoils are more or leſs abſorbent; that when any ſoil is left to itſelf, and no crops carried off, the vegetable food is always on the increaſe; that any ſoil may be managed in ſuch a manner as to enable it to attract this food in greater plenty from the atmoſphere; and that the vegetable food in any ſoil may be increaſed by mixing with it vegetable or animal ſubſtances.

He inquires into the nature of the vegetable paſture; and ſhows, that it is enlarged by ſtirring and turning over the earth, by expoſing the earth to the influence of the air, and by the application of ſuch manures as raiſe a fermentation.

He attempts to ſhew, that vegetable food may exiſt in the earth in an uſeleſs, even in a hurtful ſtate; and propoſes methods for diſſolving this food, and rendering it proper nouriſhment for plants.

The impediments to vegetation, which he mentions, are weeds and too much water; the bad effects of which are repreſented.

He divides weeds into three claſſes. In the firſt he places the weeds propagated by the ſeed; in the ſecond, thoſe that are propagated by the root; and, in the third, the ſhrubs by which ſome of the land in Scotland is greatly infeſted. Methods are propoſed for deſtroying the weeds belonging to each of theſe claſſes.

He inquires into the cauſes of the wetneſs of land, and endeavours to ſhow, that this may be owing to its ſituation, liable to be oveflowed by the water from higher ground; to the nature of its bottom, that forces out, in ſprings, the water that runs below the ſurface; to the climate in which there is too much rain; and to the nature of the ſoil, which retains too large a quantity of water. Methods are propoſed for removing the wetneſs of land ariſing from all theſe cauſes.

In book 2. the author treats of tillage.

He divides ſoils into ſuch kinds as require a different management with reſpect to tillage.

He mentions the different inſtruments employed in tillage, and ſhows the manner of conſtructing and uſing theſe inſtruments.

He examines the different ploughs uſed in Scotland, and ſhows the advantages and diſadvantages of each. He gives a very particular deſcription of the Scots plough, of its ſeveral parts, their uſes, proportions, and poſitions; and he propoſes ſome alterations for its improvement.

He inquires into the deſigns propoſed by tillage, and ſhows how this work is to be performed, ſo as to anſwer theſe.

He conſiders the uſes of ridges, and points out the kinds moſt proper. He ſhows that all ridges ſhould be ſtraight and equal, and that they ought to be broad or narrow, high or flat, according to the nature of the ſoil.

He alſo treats particularly of the altering of ridges, their poſition, and the different ways in which they are ploughed.

He deſcribes the different kinds of harrows and rollers, and repreſents the advantages of harrowing and rolling.

In book 3. he treats of manures.

He inquires into the nature of manures, and the manner of their operation; and ſhows that they operate in all the ways by which vegetation is promoted.

He examines ſeparately the manures uſed in Scotland. He repreſents the qualities of each, the manner of their operation, and their effects upon ſoil. Dunghills are alſo particularly treated of, both the ordinary dunghills of the farm, and the compound dunghills made in the fields.

In book 4. he treats of ſoils.

He divides ſoils into ſuch kinds as require a different management with reſpect to the application of manures.

He examines the different ſoils in Scotland, conſiders the qualities and defects of each; and ſhows what manures are moſt proper for improving their qualities, and ſupplying their defects.

If this treatiſe meets with a favourable reception from the public, and is found of any uſe to the farmer, the author propoſes to publiſh another part; in which ſome general directions will be given with reſpect to the management of a farm; the different ſchemes of huſbandry in the ſucceſſion of crops examined; the culture of particular plants treated of; and the methods of incloſing and planting, ſo far as they concern the farmer, pointed out.

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A
TREATISE
OF
AGRICULTURE.

BOOK I.

Of VEGETATION.

CHAP. I.

Of the Deſign.

AGRICULTURE is an art, by which the earth is aſſiſted in the production and nouriſhment of uſeful plants. That this operation may be performed in the moſt proper manner, it is neceſſary to know theſe things following: By what methods vegetation is promoted; what are the impediments to it; and how theſe impediments may be removed. To inquire into theſe things, is the deſign of this book.

CHAP. II.

Of the methods of promoting vegetation.

PLANTS conſiſt of theſe three principal parts; the root, the ſtem with the leaves, and the fruit or ſeed. By nature they are directed to puſh their ſtems into the air, and their roots into the earth. Upon the ſtems they carry their fruit or ſeed; and by the roots they receive their nouriſhment. They are of different kinds and natures, adapted to the different ſoils and climates. When in their natural ſoils and climates, they are brought to maturity by the earth without any culture: however they may be rendered more luxuriant by culture; and may likewiſe be brought to maturity in ſoils and climates, to which they are not natural. As they puſh their roots into the earth, and by them receive nouriſhment, their vegetation may be promoted by the following methods: By communicating to the earth their proper food; by opening the earth, and thereby allowing them more eaſily to extend their roots in ſearch of their food; and by diſſolving the vegetable food in the earth, and fitting it for entering their roots.

EXPERIENCE teaches us, that vegetation is promoted by all theſe methods mentioned.

BY the application of ſome manures we can improve the moſt barren land, and render it fertile; and, by the culture of ſome kinds of plants, can reduce the ſame land to its original barrenneſs. This ſhews, that the food of plants may be communicated to the earth, and that thereby vegetation is promoted.

THE great advantages, which, it is obvious,

vious, are gained by dividing the particles of the earth, whether this is done by tillage, by manures, or by froſt, plainly ſhow, that vegetation is alſo promoted, by allowing plants more eaſily to extend their roots in ſearch of their food.

BY the application of ſome manures, we can make land exert itſelf beyond its natural ſtrength in the nouriſhment of plants; and thereby reduce it to a greater degree of barrenneſs, than it is poſſible to do without their aſſiſtance. This ſhows, that there is ſometimes vegetable food in the earth undiſſolved, or in ſome form, that prevents its operation; and that, by diſſolving, or ſome way bringing it into action, vegetation is likewiſe promoted.

CHAP. III.

Of the food of plants.

IT has been obſerved, that the vegetation of plants is promoted by communicating to the earth their food. This makes it neceſſary to inquire, what is the real food of plants, or by what things they are nouriſhed. This is an important inquiry, and no leſs difficult than important. There is not any thing concerning which there is a greater variety of opinions. It will not be improper to mention theſe opinions; examine what has been advanced in ſupport of each of them; and conſider, whether there are a ſufficient number of obſervations and experiments to determine the queſtion.

Some are of opinion, that water is the food of plants; others contend for air; a third ſort for earth; a fourth for oil; and a fifth for ſalt. Beſides all theſe, there are ſome of opinion, that the food of plants is a compound of all theſe ingredients.

Before we proceed to examine theſe different opinions, it is neceſſary that we underſtand them, and fix the meaning of the terms uſed, particularly the meaning of water, air, and earth. And this is the more neceſſary, as the writers on the different ſides do not ſeem to underſtand the opinions of each other; and differ widely in the meaning which they affix to theſe terms. Thus, when perſons aſſert that water is the food of plants, by water they mean that fluid which falls in rain and dew, and is found in wells and rivers *. But their opponents, when ſhowing that water is not the food of plants, mean by it a fluid, out of which a ſkilful chymiſt has extracted all the earth, oil, and ſalt, which it originally contained.

WHEN perſons aſſert, that air is the food of plants, they mean, that the earth receives its fertility from the air. But their opponents make them aſſert, that the earth is of no uſe but to ſupport plants; and that they receive all their nouriſhment from the air immediately,

without

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* This muſt be their meaning; for the water which they uſed in the experiments upon which their opinion is founded, was of this kind. Helmont uſed rain-water.

without its being communicated firſt to the earth *.

When perſons aſſert that earth is the food of plants, they mean the fine particles

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* This is what Mr Tull makes Mr Bradley aſſert; and to confute this aſſertion obſerves, that, if it was true, there would be little or no difference in the value of rich or poor land, dunged or undunged; and no neceſſity either for dung or tillage. See *Tull's huſbandry, chap.* 2. *Of the food of plants.* Who would imagine, that Mr Tull, in this place, is confuting an opinion formed by himſelf? and yet it is certain. When Mr Bradley aſſerts that the earth is of no uſe, but to ſupport plants, it is plain, he means the *caput mortuum* of the chymiſts, earth ſeparated from all its juices. What he aſſerts, is this: It is not the ſoil or earth itſelf which affords ſufficient proviſion for the ſeveral plants and vegetables; but there are reſiding in the earth ſome agreeable juices to nouriſh plants; and as theſe juices are more or leſs abundant, the vegetables planted are more or leſs vigorous: and he ſuppoſes theſe juices or ſalts are furniſhed by the air. After mentioning Helmont's experiment, he adds, “ I have made ſome others of the ſame kind, “ and find the plant has little more uſe of the earth it “ ſtands in, than the keeping it fixed and ſteady.” This is what Mr Tull takes hold of: but he ſhould have attended to what follows. “ But then as earths are more or leſs binding, the ſalts or juices proper for vegetation, have leſs or “ more liberty to act. —— I ſuppoſe, that all bodies of “ earth are more or leſs capable of imbibing the fluent air, “ and

ticles of it, moiſtened with water, and impregnated with oils and ſalts. But their opponents mean by it the *caput mortuum* of the chymiſts *.

IT

" and of attracting ſuch ſalts, as either the air can give, or " the earth is capable of receiving.—— Earths themſelves " being of different kinds, ſome ſorts cannot take in ſo " many of the nouriſhing parts of the air as others; and " therefore the ſame ſort of plants cannot grow in every " ſoil with like vigour." Mr Bradley's opinion cannot be miſtaken by any perſon, that impartially conſiders what he has wrote. It is this: The nouriſhing juices are in the air; but they are imbibed by the earth before they become the food of plants. Now, Mr Tull has ſaid nothing to confute this opinion. The direction which nature has given plants to ſeek their food by puſhing their roots into the earth; the difference of ſoils; the neceſſity of dung and tillage, mentioned by him, are all conſiſtent with it.

* See *Complete body of huſbandry, book* 6. *chap.* 6. *Of the nouriſhment of plants, p.* 270. " We do not mean by " earth, when we ſpeak of it as the food and nouriſhment " of plants, that ſimple elementary ſubſtance which the " chymiſts mean by the ſame word, underſtanding by it " earth diveſted of all other principles: on the contrary, " we can extract all thoſe principles from plants; and we " mean no other by earth, on this occaſion, than ſuch as " compoſes a fine ſoil, ſuch as it is found on the ſurface of " land, and is called mould." See likewiſe *Du Hamel de la culture des terres, tom.* 1. *chap.* 3. *La terre dont nous parlons n'eſt point une terre ſimple, elementaire, ou un* caput

mortuum:

It is but reaſonable to allow every perſon to explain his own terms: and therefore, when we examine the opinions of thoſe who aſſert that any of the particulars mentioned is the food of plants, we are not at liberty to affix to their terms a meaning of our own, though it may appear the moſt proper; but are to

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mortuum: *car on peut retirer des plantes mortes tous les principes qu'on vient expoſer.*

Tull muſt be excepted: When arguing that earth is the food of plants, he ſeparates it from water, air, and fire, and endeavours to ſhow that theſe things are for no other uſe, but to convey the earth into their roots, and preſerve the motion of their ſap: and, when treating of tillage and manures, aſſerts, that all that is neceſſary to promote vegetation, is to pulverize the ſoil; which is carrying this error, if it is an error, into its moſt dangerous conſequences. But we may obſerve, that, when treating of the paſture of plants, he ſays, that the particles of earth, which go to the food of plants, are ſmaller than many of the particles mixed with the cleareſt water, probably as ſmall as thoſe upon which the colour of bodies depends: that particles much larger than theſe are exhaled with vapour, and are divided by the aëreal nitre into ſmaller ones, and fall down in rain and dew to repleniſh the vegetable paſture. And thus he makes the particles of earth, which are the food of plants, different from ordinary earth; or rather turns it into a ſubtile fluid, partaking of the virtues of the atmoſphere.

underſtand them in the ſame ſenſe with thoſe that uſe them. Affixing then to water, air, and earth, the ſame meaning with thoſe who aſſert that they are the food of plants; let us examine the different opinions mentioned, and conſider what is advanced in ſupport of each of them.

THOSE who contend that earth is the food of plants, obſerve, that all plants grow in the earth, and are nouriſhed by it; and that even thoſe plants which we ſee growing in water, and ſeem to be nouriſhed by it, have their roots fixed in the earth.

THOSE that contend for water, obſerve, that there are no plants that can live without water; that there are many that grow in it, and are nouriſhed by it without any earth; and that there are ſome that ſeem to have no need of the earth upon which they ſtand, but to ſupport them, as is the caſe with many of the ſea-plants, which grow upon the hardeſt rocks. To theſe obſervations, they add an experiment made by Helmont upon a willow, which increaſed to a conſiderable bigneſs, fed by water only *.

Those that contend for air, obſerve, that ſome plants, particularly the tree ſedum, will live many years ſuſpended in the air, and put forth roots in moiſt weather: and from this allege, that they would grow in this ſituation, provided the air was at all times ſufficiently moiſt †. To this they add a variety of experiments, tending to ſhow that the earth is rendered fertile by the air. We ſhall only mention a fact which may have come under the obſervation of all perſons. 'Tis a common cuſtom, in many places, to manage outfield-land in this manner. Three

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* The experiment made by Helmont was this. He planted a willow, of weight 5 lb. in a pot filled with dry earth, and covered with a perforated tin-cover. This earth he watered with rain-water. In five years, the willow was increaſed to 169 lb. 3 oz. and the earth had loſt nothing.

† See *Bradley's treatiſe of huſbandry and gardening, vol.* 1. *p.* 37.

or four crops are taken off, and then the land is allowed to reſt for ſix or ſeven years. The firſt crop is always the beſt, and the laſt crop the worſt: a certain evidence that the land became more fertile by being allowed to reſt: and from whence can it be ſuppoſed that it received its fertility, but from the air? In this caſe, it is vain to mention pulverizing; for the land, when leaſt pulverized, carries the beſt crop; and, when moſt pulverized, carries the worſt.

THOSE that contend for oil, obſerve, that in proportion to the oil contained in any ſoil, the ſoil is rich and fruitful; in proportion to the oil contained in any manure, the ſoil upon which it is laid is enriched; and, in proportion to the oil, or ſpirit, which any plant contains, it robs the ſoil, by which it is nouriſhed, of its vegetable food.

THOSE that contend for ſalts, obſerve, that ſalt itſelf is a manure; and that every other manure contains ſalt, or has a power to produce it, by its fermentation with acids.

THUS, we ſee that there are obſervations and experiments to ſupport each of theſe opinions; and, when we conſider theſe obſervations, we cannot but allow that ſome of the things mentioned actually contain the vegetable food, and that the others are neceſſary ingredients in it. When we conſider that plants are actually nouriſhed by earth; that they are alſo nouriſhed by water; and that the earth is rendered fertile by the air; we cannot but allow, that all theſe, in ſome ſenſe, may be called the food of plants; at leaſt, that they contain this food. And when we conſider, that earth is rendered fertile by being mixed with oil and ſalt, and rendered poor and barren, when theſe are extracted; we muſt alſo allow, that theſe things, in ſome ſenſe, may likewiſe be called the food of plants; or, at leaſt, are neceſſary ingredients in it. But then we can, by no means, allow the inferences which theſe perſons make from their obſervations.

ſervations. For they infer from them, that the particular things for which they contend, not only nouriſh plants, but are the only things that nouriſh them, excluſive of all others. Thus, thoſe that contend for earth, will not allow that either water or air are any parts of the food of plants; but only neceſſary agents in promoting vegetation, while the earth contained in them is the only nouriſhment. And, in like manner, it is with thoſe that contend for the other particulars mentioned. It is in thus making inferences from their obſervations, which they will not bear, that the error of all of them lies. For while their obſervations do no more than ſhow, that the particulars, for which they contend, contain the food of plants, or are neceſſary ingredients in it; they inſiſt, that it alſo follows from them, that theſe particulars are the only food of plants; or are the food of plants in a ſenſe peculiar to themſelves. This error, it may be obſerved, is a moſt dangerous one: for if, in practice, we confine our attention to one of theſe as the vegetable food, without having a regard to any other, we will retard rather than promote vegetation; at leaſt, vegetation will not be ſo effectually promoted, as when our attention is extended to all the things which experience teaches us are proper for this purpoſe.

HAVING thus ſhown, that neither earth, nor water, nor air, nor oil, nor ſalt, can properly be called the food of plants, though ſome of them ſeem to contain this food, and the others to be neceſſary ingredients in it; let us now inquire, if a compound of all theſe ingredients better deſerves this name. And now let it be remembered, that when it was allowed that earth, and water, and air, contain vegetable food; by them was meant the things to which theſe names are commonly given, and not the ſimple things to which theſe names are given by the chymiſts. As they are all compound ſubſtances, we are naturally led to infer, that the vegetable food is itſelf a compound ſubſtance, or, if a ſimple, is an ingredient in every one of the compound ſubſtances, found from experience to contain this vegetable food. Thoſe things, to which the names of earth, water, and air, are commonly given, have been examined by chymiſts: it is found that all of them are compounded of the ſame ingredients, and that their different appearances ariſe from different proportions of theſe ingredients. In each of them is found a ſolid heavy body, which prevails moſt in earth; a denſe fluid, which prevails moſt in water; and a ſubtile and elaſtic fluid, which prevails moſt in air: Or, in other words, earth is always mixed with a quantity of air and water; air with a quantity of water and earth; and water with a quantity of earth and air: and, beſides theſe, there is found in every one of them, a quantity of oil and ſalt.

THE vegetable food then muſt either be one of theſe ingredients, or a compound of ſome, or all of them. It is obvious, that there is not one of them that can be called the vegetable food, excluſive of the others. For every one of them is not only neceſſary to promote vegetation, but alſo contributes to the increaſe of the plant. It is certain, that none of them can be wanted. Let the oil be extracted from any ſoil, and experience teaches us, that it becomes quite barren, and incapable of nouriſhing plants: let the ſalt be extracted, and the oil will neither diſſolve, nor mix with water: let the water be extracted, and plants cannot receive any thing into their roots: let the air be extracted, and the motion of the juices is immediately ſtopped, and plants can receive no more food: let the earth be extracted, and plants cannot extend themſelves, nor their parts have ſufficient coheſion to form them into any ſhape. As all theſe things, then, are neceſſary to promote vegetation, and plainly tend to the increaſe of the plant; it is natural to conclude, that they are all neceſſary ingredients in the vegetable food.

BUT as this is a matter of importance,

it is neceſſary to examine it farther; and to inquire, if there are any other obſervations that tend to confirm this opinion.

CHYMISTS aſſure us, that plants contain all the ingredients mentioned, and no other. Now, if a perſon diveſts himſelf of prejudice, and attachment to any particular opinion, it would naturally occur, one would think, that the food of plants is compounded of the ſame things, of which plants themſelves are compounded. For it is not poſſible to conceive how any thing can be in the plant, unleſs ſomething of the ſame kind is in the compoſition of its food.

EXPERIENCE teaches us that vegetables, when mixed with any ſoil, render it more fertile. It is natural to infer from this, that vegetables are food to vegetables, as animals are food to animals. To render them proper food, it is indeed neceſſary that they be diſſolved, their parts ſeparated, and thereby fitted for entering the ſmall pores of roots. But this is effectually done by corruption. If vegetables then are proper food to vegetables, it follows, that vegetables and their food are compounded of the ſame things.

ALL the things which experience teaches us enrich land, when examined, are found to contain in themſelves one or more of the ingredients mentioned, or to have a power of attracting them from the air.

ANIMALS, we find, are nouriſhed by a variety of different things; ſome by different kinds of other animals, and others by different kinds of vegetables. Suppoſe it is inquired, what is the animal food? It would appear abſurd at firſt ſight, ſhould one perſon inſiſt, that fleſh is the animal food; a ſecond, in oppoſition to him, that it is fiſh; a third, in oppoſition to both, that it is milk; and a fourth, in oppoſition to all three, that it is vegetables. We know that all theſe are the animal food, but none of them excluſive of the others. When it is inquired, what is the vegetable food? it is equally abſurd for one to inſiſt that it is earth; another, in oppoſition to him, that it is air; and a third, in oppoſition to both, that it is water. All theſe contain vegetable food; but none of them excluſive of the other two. All the things which experience teaches us are the animal food, have been examined; and it is found, that they are different compoſitions of air, water, earth, oil, and ſalt; and no perſon is in the leaſt doubt, that theſe things, modified in a certain manner, are the animal food. So when the things which experience teaches us are nouriſhment to vegetables, are found to contain the ſame ingredients, we have as little reaſon to doubt that theſe ſame ingredients, modified in a certain manner, are alſo the vegetable food.

NOTHING more, then, ſeems neceſſary to determine that the food of plants conſiſts of air, water, earth, oil, and ſalt. To theſe Dr Home adds fixed fire; but this is certainly comprehended in oil. For oil is nothing but fixed fire, or a compound of fixed fire and water.

In a matter of this kind, in which many learned men have been miſtaken, it would be the height of ſelf-conceit to pretend to certainty. However, let it be obſerved, that though this opinion may be erroneous, yet it is not ſo dangerous, when reduced to practice, as the other opinions are, which make only one of the ingredients of this compoſition the vegetable food. If, in practice, we ſuppoſe, that one of theſe only is the vegetable food, and in this are deceived, the conſequence muſt be fatal, as we proceed upon a wrong principle *: but if, in practice, we

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* Perſons in practice may however ſafely proceed upon the ſuppoſition that oil and ſalt are the vegetable food. For theſe things we ſtand in greater need of, and they are more in our power, than the other ingredients. Earth and air are found almoſt every where, and water is ſupplied from the heavens. Nature has made a very proper diſtribution of them. In ſome places indeed, and on ſome occaſions, we find them in ſmaller quantities than are neceſſary: but then

we ſuppoſe that the vegetable food is compounded of all the ingredients mentioned, and provide as many of them as we can; there can be no great miſtake, though, among theſe, there may be ſome things which cannot properly be called the vegetable food, provided that they are uſeful in promoting vegetation. Experience, as I have already obſerved, ſhows us, that every one of theſe ingredients is of uſe, and aſſiſts in promoting vegetation; and therefore the providing as many of them as we can, muſt always be an advantage. If this then is an error, we may preſume to ſay, it is not a dangerous one: If reduced to practice, it will not far miſlead us; and therefore we may proceed

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we may obſerve, that they are not at our command; and we can provide only a ſmall ſupply of them. It is not ſo with oil and ſalt: there is not an equal diſtribution of them: in ſome places they are in great plenty; in others are ſcarcely to be found. It may be obſerved likewiſe, that we have them at command; and, with very little trouble, can carry, from one place to another, as large a quantity as is neceſſary. Experience has led the practical farmers into the opinion, that theſe things are the food of plants. For we find that they ſet the higheſt value upon ſuch manures as contain the greateſt plenty of them.

proceed upon it with the greater boldneſs.

PERHAPS it may be thought not improper, to take ſome notice of what Mr Tull has ſaid, in ſupport of his opinion; as he ſeems ſo poſitive, and ſo fully convinced, that he has confuted others. This is the more neceſſary, as his arguments are uſed by the authors of the *Complete body of huſbandry*, and by Du Hamel, in his treatiſe *de la culture des terres.*

THE arguments uſed by Mr Tull are as follow: when conſidered, they will not appear ſo concluſive as he imagined they were.

"THAT which nouriſhes and aug-
"ments a plant, is the true food of it."

No perſon doubts of this: and Mr Tull imagined the conſequence ſo obvious, that he has not taken the trouble to infer it; and yet in this lies the miſtake. It is not earth alone that either nouriſhes or augments a plant.

Chymiſts aſſure us, that mere earth is but a ſmall part of any plant.

"EVERY plant is earth, and the "growth and the true increaſe of a plant "is the addition of more earth."

THIS is denied. Every plant is more than earth, and more than earth is neceſſary to the growth of it.

"SUPPOSE water, air, and heat, could "be taken away, would it not remain to "be a plant, though a dead one?"

IT would not. Such a queſtion, with reſpect to an animal, would appear abſurd at firſt ſight. A dead animal is an animal, the motion of whoſe juices is ſtopped. But deprive it of water, air, and fire, and it is no more an animal, than a piece of clay of the ſame ſhape is an animal. In like manner, deprive a plant of every thing but earth, and it is no more a plant; it wants thoſe things which diſtinguiſh a plant from another piece of matter.

“ But ſuppoſe the earth of it taken
“ away, what would then become of the
“ plant?

It would be no more a plant, but there would remain water, air, oil, and ſalt.

“ Too much nitre (or other ſalts) cor-
“ rodes a plant; too much water drowns
“ it; too much air dries the roots of it;
“ too much heat or fire burns it; but too
“ much earth a plant never can have, un-
“ leſs it be therein wholly buried.”

In a diſpute about the animal food, it would be abſurd to argue in this manner. Too much ſalt exhauſts the juices of an animal; too much water drowns it; too much (too denſe) air ſtops the motion of its blood; too much heat burns it; too much oil turns it ſick: therefore none of theſe things are the food of the animal. It is is equally abſurd, to argue in this manner with reſpect to a plant. Still it may be urged, “ a plant never can “ have too much earth.” The reaſon is obvious: A plant cannot receive earth, without the aſſiſtance of fluids; but it can receive fluids without earth: fluids therefore, or any thing eaſily diſſolved in them, may deſtroy it; but earth cannot.

“ COMMON earth, with the proper “ ſhare of the other elements, will nou- “ riſh any plant.”

THE earth which Mr Tull uſed in his experiments, was not ſeparated from its ſalts and oils. This cannot be done entirely; but when done as much as poſſible, the earth is found very barren, and not able to nouriſh many kinds of plants. Chymiſts find that the ſoil which produces the beſt crops, and is reckoned the richeſt, contains the greateſt proportion of oils and ſalts.

THE authors of the *Complete body of buſbandry* have done no more than enlarge upon Mr Tull's arguments; unleſs this be thought an argument: "We "find that all vegetables are finally re"duced to earth by corruption; and to "what ſhould a thing be reduced by "this, but to that ſubſtance of which "it originally conſiſted?"

DUST thou art, and to the duſt thou ſhalt return, may be addreſſed either to animals or vegetables. But ſtill it is abſurd to ſay, that animals feed upon earth, and conſiſt of earth. The queſtion is not, Whether plants and animals are formed of matter, and are nouriſhed by matter? It is, Of what kind of matter are they formed, and by what are they nouriſhed? whether earth only, or earth mixed with other things? It is no evidence, that it is earth only of which they are formed, and by which they are nouriſhed, becauſe corruption reduces them to earth. For it is certain that their ſalts and oils become volatile, and fly off into the air, and their other juices are exhaled by the heat of the ſun.

OILS and ſalts have been mentioned as parts of the vegetable food. The authors of the above-mentioned Body of huſbandry, take notice of ſome facts, which, in their opinion, overturn this ſyſtem entirely. It is proper, before we leave this ſubject, to conſider theſe facts. They are mentioned by them in theſe words. "We have ſhown, in our ſecond book, "what are the ſeveral ſubſtances uſed as "manures; and, from many of theſe, "one would be led to ſuppoſe, that the "ſap, which is ſo evidently increaſed "and enriched by them, conſiſted of ſalts "and oils, and other things, ſuch as "chymiſtry is able to extract from theſe "ſeveral ingredients. But then the effects "of many of the more ſimple kinds "of theſe manures, which are often "equal to the moſt ſeemingly power-"ful, ſhow that this is not the caſe: and "we are the more confirmed in this, "when we conſider that bare ſands will "ſupport many plants, and that many "others may be raiſed in pure water; "and that, in either caſe, they have the

" ſame qualities and virtues with thoſe
" of the ſame kind, raiſed in earth dreſſ-
" ed with the richeſt manures."

The deſign of this long paragraph is to ſhow, that ſalt and oil are no parts of the food of plants. As a proof of this theſe facts are produced. The effects of ſome manures which contain neither ſalt nor oil, are often equal to thoſe other manures that contain theſe: vegetables grow in ſand, and are nouriſhed by water. It has already been ſhown, that the nouriſhing of plants by water, is an evidence that ſalt and oil are parts of their food. Their growing in ſand is alſo an evidence of this. For in this ſand are found theſe ſame ingredients. The operation of the manures that contain neither ſalt nor oil, is therefore the only thing to be conſidered. It is acknowledged, that lime, and ſome other manures of the ſame kind, promote vegetation very powerfully in ſome ſoils: and it is acknowledged likewiſe, that they contain in themſelves neither oils nor ſalts. But, when the nature and operation of manures is treated of, it will be ſhown, that theſe manures promote vegetation, not only by enlarging the paſture of plants, but alſo by forming ſalts; attracting and diſſolving oils; and, therefore, that their influence in promoting vegetation, is no evidence that ſalts and oils are no parts of the vegetable food.

HAVING thus ſettled this important point, and ſhewn what is the food of plants, it will not be improper that we inquire likewiſe, whether or not all plants have the ſame food? In this inquiry, two queſtions are to be reſolved.

I. WHETHER the ſame individual thing, ſimple or compound, that nouriſhes one plant, will nouriſh every plant?

II. WHETHER nature has given plants the faculty to chuſe what food is proper, and to reject what is improper?

THESE queſtions have been generally

blended together by writers on this ſubject. But they are to be conſidered as quite ſeparate and independent.

WITH reſpect to the firſt of theſe queſtions, there are three opinions.

SOME affirm, that every particular kind of plant has its own peculiar food, and that this food is different from the food of every other kind.

OTHERS affirm, that all plants are nouriſhed by the ſame food; and that the food that nouriſhes one plant, will, as to the kind of it, nouriſh any plant.

A THIRD ſort affirm, that plants may be compared to animals. Some kinds of animals, it is certain, ſuch as horſes, cows, and ſheep, are nouriſhed by the ſame food: other kinds, ſuch as dogs and fiſhes, are ſo different in their natures from theſe, that they require different food. So it is, ſay they, with plants. Some kinds of them, ſuch as wheat and barley, are nouriſhed by the ſame food; but other kinds, ſuch as ruſhes and ſea-weed, are ſo different in their natures from theſe, as to require different food.

THE firſt opinion ſeems very improbable. The argument advanced in ſupport of it, is far from being concluſive. In the words of Dr Woodward, "It is "not poſſible to imagine, how one uni-"form homogeneous matter, having its "principles or original parts, all of the "ſame ſubſtance, conſtitution, magni-"tude, figure, and gravity, ſhould ever "conſtitute bodies ſo egregiouſly unlike, "in all thoſe reſpects, as vegetables of "different kinds are; nay, even as the "different parts of the ſame vege-"tables."——"That there ſhould be "that vaſt difference in them, in their "ſeveral conſtitutions, makes, proper-"ties, and effects, and yet all ariſe from "the ſame ſort of matter, would be very "ſtrange."

IN anſwer to this, it may be ſaid, that

it is as difficult to imagine, how a ſmall ſpot of earth ſhould contain ſo many thouſands of different juices, as is neceſſary upon this ſuppoſition; all the different juices neceſſary for the different plants, and all the different juices neceſſary for the different parts of the ſame plant. This however muſt be true, if the food of one plant is different from the food of every other plant. For a quantity of earth may be produced, which will bring any terreſtrial plant to perfection; and therefore muſt contain the juices of all of them, and of all their parts.

BUT it is ſtill more difficult to imagine, how the root ſhould convey to the plant ſuch a variety of different juices. There is ſcarcely a kind of tree, but may be ingraffed into any other kind. So that the roots of the ſtock convey to the tree all the different juices, which the different graffs require. Mr Tull aſſures us, that the ſap of the birch will nouriſh every kind of vegetable capable of being nouriſhed by water; ſo that the roots of this tree muſt take in all the different juices that the different aquatics require. Beſides, it is certain, that all the different taſtes and ſmells which we find in plants, are formed in the plants themſelves: for chymiſts, after the ſtricteſt ſcrutiny, can find but few of them in the earth. An experiment made by Du Hamel, puts this matter beyond all diſpute. He ingraffed a young lemon, of the ſize of a pea, upon the branch of an orange-tree. It grew there, ripened, and had all the qualities of the lemon, without partaking of any of the qualities of the orange. It is evident in this inſtance, that the ſtalk of the lemon changed the colour, taſte, and ſmell of the juices of the orange-tree. And, from this experiment, we have reaſon to conclude, that all the different figures, colours, taſtes, and ſmells, which we find in the different plants, are formed in the plants themſelves.

DR HOME, to prove that the food of vegetables is not all of the ſame kind, uſes the following argument. "We "know that ſome trees contain the acid "of vitriol; for, with their charcoal, "we can make a ſulphur. We know "likewiſe, that ſome plants contain a "nitrous ſalt, while others one like ſea-"ſalt *." If this proves, that the food of plants is not all of the ſame kind, it muſt prove alſo, that all the different kinds of ſalts, acids, &c. are neceſſary in the compoſition of this food. For, if the finding different ſalts in different plants, is an evidence, that theſe plants have different food; it muſt be allowed, that the ſame kind of ſalts found in the plants, exiſts alſo in their food; that the plants that contain a nitrous ſalt have a nitrous ſalt in their food, and the plants that contain ſea-ſalt have ſea-ſalt in their food. But is it not more natural to ſuppoſe, that the different ſalts found in the different plants, are formed by the plants themſelves? May not we ſuppoſe, that plants have a power to unite the original ſalt of the vegetable food with ſome of its other ingredients, in ſo cloſe a manner, as not to

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* P. 106.

be ſeparated by any chymical operation, and thereby form other ſalts? The Doctor himſelf infers ſomething like this from Homberg's experiment. “This experiment,” ſays he, “ſhows, that the veſſels of plants have a power of changing the ſalts taken in from the earth, into their own particular natural one, probably by combining them with different proportions of water, oil, earth, air, and the particles of light which iſſue from the ſun *.” If plants have this power, one kind of ſalt being found in one, and another kind in another, is no evidence that the food of plants is different.

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* Homberg filled two pots with earth, mixed with a quantity of ſaltpetre; and two others with earth, out of which he had waſhed all its ſalts. In one of the pots with the ſalted earth, and in one of thoſe with the waſhed earth, he planted fennel: in the other two he planted creſſes. The plants in the pots with the ſalted earth grew larger than thoſe in the others. He diſtilled all of them, and found, that the different food had not altered their natures. The creſſes, though differently fed, were compounded of the ſame ingredients. So were the plants of fennel. None of the plants of creſſes gave an acid ſalt, though one of the plants had this ſalt in its food. Both the plants of fennel gave an acid ſalt, though one of them had none in its food.

We obſerved, that as there are ſome who affirm that every kind of plant has its own peculiar food; ſo there are others who are of opinion, that all plants have the ſame food; that the food which nouriſhes one plant, will, as to the kind of it, nouriſh any plant. This opinion is directly oppoſite to the former, and nothing leſs improbable; notwithſtanding all that Mr Tull, and others ſince, have ſaid in ſupport of it. This opinion is embraced by all thoſe who aſſert that the food of plants is a ſimple. For if either earth, or air, or water, is the food of plants, it follows, that all plants have the ſame food. But if the food of plants is compounded of ſeveral ingredients, then it is probable that the different plants require different proportions of theſe ingredients. Though plants have all the ingredients mentioned in their compoſition, yet they have them in very different proportions. It is obvious to a common obſerver, that ſome plants contain a greater proportion of oil in their compoſition, and others a greater proportion

tion of ſalt: and therefore, though plants require all the ingredients mentioned in the compoſition of their food; yet may not require them exactly in the ſame proportions. It is natural to think, that the plant which has a greater proportion of oil in its compoſition, requires a greater proportion of oil alſo in its food; and that the plant which has a greater proportion of ſalt in its compoſition, requires a greater proportion of ſalt alſo in its food; and that, if too great a proportion of oil is applied to the plant that requires ſalt, or too great a proportion of ſalt to the plant that requires oil; theſe things, thus miſapplied, will prove poiſon inſtead of food.

BUT, for the illuſtration of this matter, let us have recourſe to facts.

IT is certain, that ſome plants require ſuch a quantity of water in their food, as will effectually deſtroy ſome others. Mr Tull allows, that the quantity of water neceſſary for the nouriſhment of ruſhes, will deſtroy thyme.

SOME plants require ſuch a quantity of ſalt in their food, as will effectually deſtroy ſome others. The ſalt water neceſſary to all ſea-plants, will deſtroy a plant of mint, if only a few of its roots are put into it; applying freſh water to the roots of ſea-plants, as effectually deſtroys them.

BESIDES theſe two opinions, we mentioned a third. There are ſome who affirm, that plants may be compared to animals; that ſome of them have a great reſemblance to others, and are fed by the ingredients of which the vegetable food is compounded, nearly in the ſame proportions; but that ſome other plants are ſo different from theſe, that they require the ingredients of this food in very different proportions. The other two opinions are the extremes; and, from what has been ſaid, ſeem improbable: this opinion is the middle betwixt them, and ſeems neareſt the truth. It is natural in itſelf; and is confirmed by the following facts.

THE ſame ſoil, prepared in the ſame manner, nouriſhes equally well a great variety of different plants. The ſame field will produce equally well a good crop of wheat, or a good crop of barley. This ſeems to ſhow, that theſe plants are nouriſhed by the ingredients of the vegetable food, nearly in the ſame proportions.

DIFFERENT plants are adapted to different ſoils. The weeds that prevail in one field, are not to be ſeen in another. Allow two fields to lie unploughed; the one lately manured, and rich, the other exhauſted by crops, and poor; though contiguous to each other, they will produce very different plants. One kind of aquatics are nouriſhed by freſh water, and another kind by ſalt. Theſe things ſeem to ſhow, that ſome plants are ſo different from others, as to require the ingredients of the vegetable food in very different proportions.

The other queſtion propoſed, is, Whether or not nature has given plants the faculty to chuſe what food is proper, and reject what is improper?

Some perſons have aſſerted that plants have this faculty. Dr Woodward ſays, "That each ſort of grain takes forth that "peculiar matter that is proper for its "own nouriſhment. Firſt, the wheat "draws off the particles that ſuit the body of that plant, *the reſt lying all quiet* "*and undiſturbed the while,*" &c. Mr Bradley ſays, "From this way of rea- "ſoning, I ſuppoſe, ſome of the moſt in- "genious huſbandmen have contrived "to ſhift their crops, from year to year, "to *eaſe the ground*; but I find few of "them to carry their judgment ſo far, "as to follow one crop with another of "ſo different a kind, *as to draw quite* "*different juices than the firſt*, or to fol- "low the ſecond with a third differing "from both."

In the practice of huſbandry, a ſucceſſion of different kinds of grain has been found preferable to the ſowing of one kind conſtantly on the ſame field. From this ſome perſons have been led into the opinion, that plants have the faculty to chuſe what food is proper, and to reject what is improper. The advantages ariſing from a change of ſpecies in agriculture, can be accounted for upon other principles; and there are many undoubted facts to ſhow that this principle is falſe.

SOME land has carried crops of the ſame kind of grain for numbers of years. Sometimes it has been tried with other grain, and the crop no better, ſometimes not ſo good.

EVERY ſpecies of vegetables robs another of its food. Weeds growing among corn, leſſen the crop according to their kinds and number. Mr Bradley ſays, that thyme, and other aromatics, if planted near an apricot-tree, will deſtroy it.

But what puts this matter beyond all diſpute, is this. Plants will receive their poiſon as well as their food. According to Dr Home's experiments, plants of barley were poiſoned by flowers of brimſtone, and alſo by ſalt of ſteel; and, according to Mr Tull's, a plant of mint was poiſoned by ſalt water. It is remarkable, that the greateſt number of the roots of the mint were in freſh water, and ſo few of them put into the ſalt water, that, if they had been cut off, the plant would have ſuſtained very little harm. As the putting theſe few roots into the ſalt water deſtroyed the plant, and as its leaves, when dead, taſted ſalt; it is paſt all doubt that the plant died, not becauſe its roots were deſtroyed, but becauſe it had actually imbibed its poiſon.

It ſeems probable then, from the whole of theſe obſervations, that the food of plants is compounded of air, water, earth, oil, and ſalt; that different plants, according to their different natures, require theſe ingredients in different proportions;

and that plants have not the faculty to chuſe ſuch things as are proper for their nouriſhment, and to reject others, but imbibe every kind of juice that touches their roots.

CHAP. IV.

Of the methods of increaſing the food of plants.

IT is probable, that a quantity of animal and vegetable food was formed at the firſt creation; and that the ſame quantity has continued ever ſince in various forms and appearances. It is uncertain, whether this food was originally in the air or in the earth. If in the air, a part of it would ſoon be communicated to the earth; and if in the earth, a part of it would ſoon be applied to the nouriſhment of vegetables, and by them communicated to the air. It does not appear that this quantity can either be increaſed or diminiſhed *. It obſerves a conſtant rotation, and is conveyed regularly from the earth to the air, and from the air to the earth. A conſiderable quantity of it is conſtantly carried from the

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* It may be alleged, that the contrary of this appears true from

from experience; that barren lands are every day enriched, and rendered more fertile; and that this is done without rendering other lands leſs fertile. This is not to be denied; and yet it does not follow that the quantity of vegetable food is actually increaſed. Lands are reckoned barren, not becauſe they do not contain vegetable food; but becauſe they are in ſuch a ſituation, as not to be capable of producing crops of corn. Now, this barrenneſs may ariſe from their being full of uſeleſs plants, which appropriate all the vegetable food in the land to themſelves; from too much water, which chills corn, and prevents it from being brought to perfection; or from the want of a proper coherence in the ſoil, and its being apt to ſwell too much with water. Of the firſt ſort is land, which is full of uſeleſs ſhrubs, ſuch as whins, broom, or bramble: of the ſecond ſort is marſhy land; and of the third is moſs. The way of improving theſe, the firſt two at leaſt, is obvious; and yet the quantity of vegetable food is not increaſed; it is only more properly applied to the nouriſhment of the plants we deſire to cultivate.

It may be further alleged, in oppoſition to what has been aſſerted, that manures are taken from the bowels of the earth, which, when laid upon land, render it more fertile. But theſe manures do not promote vegetation by increaſing the vegetable food; but by altering the form of that food which the ſoil already contains, and fitting it for the earth to the ſea by rivers; and this is reſtored to the earth by fiſh and ſea-weed, or conveyed to the air by exhalations.

But though we cannot increaſe the vegetable food in the general; yet, by proper

for the nouriſhment of plants; and by enabling the ſoil to attract it in greater plenty from the air. This power communicated to the ſoil, of attracting the vegetable food in greater plenty from the air, makes the original quantity go a greater length in the nouriſhment of plants, by confining a greater proportion of it to the earth, or, which is the ſame thing, by making it return more quickly from the air. For, by increaſing this attractive power in the earth, the vegetable food, which would continue hovering in the air, till the quantity was conſiderably increaſed, is brought down to the earth; and thereby the quantity in the air rendered ſmaller, and its return to the earth quicker, than otherwiſe it would be. This may poſſibly be one reaſon why a country becomes more healthful, when the lands are improved, than when allowed to lie uncultivated.

Besides, it is uncertain what the manures taken from the bowels of the earth are compounded of. That earth is often turned into metals, at leaſt into ſtone, is almoſt certain. No perſon that has attentively viewed rocks, will doubt of this. In them are found pebbles, ſhells, and bones; an evidence that they have been ſome time or other a liquid compoſition. And as earth may be turned into ſtone, per management, we may increaſe the quantity upon any particular ſpot. There are two different ways by which the food of plants may be increaſed.

It may be increaſed by managing the ſoil in ſuch a manner, as to enable it to attract this food in greater plenty from the air.

It may be increaſed likewiſe by mixing with the ſoil ſuch bodies as contain thoſe ingredients of which the vegetable food is compounded.

From what was ſaid in the laſt chapter, it ſeems very probable, that the air contains vegetable food; and that, as ſome perſons aſſert, it is from the air that the earth, in a great meaſure, receives its

ſtone, ſo ſtone may be turned into kinds of earth, ſuch as clay or marles. This makes it poſſible that lime-ſtone, marles, and the other manures of that kind, may have had ſome animal or vegetable ſubſtances in their original compoſition; and therefore, though they add vegetable food to the land on which they are laid, yet there is no increaſe of the original quantity.

fruitfulneſs, it is neceſſary to inſiſt upon this more fully in this chapter.

It has been already obſerved, that both plants and animals are compounded of the ſame ingredients, of which the vegetable food is compounded. When any of theſe die, all their parts, the earthy ones excepted, fly off into the air. When we approach a body that is putrefying, we are made ſenſible by the ſmell, that ſome kind of matter is flying off from it into the air: and we find that both plants and animals, when putrefied, are waſted, a little earth only remaining. This earth is of the abſorbent kind, and retains ſome ſalts and oils; but a very ſmall quantity in proportion to what was originally in the plant or animal.

Rain, it is obſerved, promotes vegetation much better than any other kind of watering; and ſnow is found to be a manure. Both rain-water and ſnow, when examined, are found to contain oils and ſalts.

SOOT is found to be a very rich manure; and contains oil, and ſalt, and earth. Soot is nothing but ſmoke collected. Smoke in great quantities aſcends into the air, and carries along with it the ingredients of which it is compounded.

SOME land has been in graſs for hundreds of years, and the graſs continues to be very rich: and ſome land has been many years in tillage, perhaps ſome hundreds likewiſe; and, during that period, at leaſt for the laſt ſixty or ſeventy years, has not received any manure, and yet continues to carry good crops. That the crops carried off vegetable food, is certain; and from whence can it be ſuppoſed that the land received a ſupply, but from the air[*]?

THESE

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[*] It may be alleged, that if the graſs, upon the land mentioned, was paſtured, and not cut for hay, a very ſmall quantity of vegetable food would be carried off. But ſtill it muſt be allowed, that this quantity would be carried off annually. And when cattle are fattened, this quantity cannot be ſo ſmall as perſons generally imagine. For it is certain, that what they leave in dung bears no proportion to.

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THESE things added to what was formerly obſerved, that land, by being allowed to reſt for ſome years, becomes more fertile, make it plain that the air is full of vegetable food. × It is from the air that the earth is ſupplied. For this vegetable food is ſucked in by the earth, as it touches its ſurface; and it is carried down by the dew, θ the rain, and the ſnow: and thus the earth, by this conſtant ſupply of vegetable food, * which it receives from the air,

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what they carry off in fleſh, and convey to the air by perſpiration. But ſuppoſing the quantity carried off annually to be but ſmall, yet, in a courſe of ſome hundreds of years, the land would be quite exhauſted, unleſs it had a conſtant ſupply: and, to account for this ſupply upon Mr Tull's principles, we muſt have recourſe to the particles of earth carried about by the winds, and falling down in dew, rain, and ſnow. ——— As to the field in tillage, it is certain that the crops carried off the vegetable food: but it may be alleged, that the land was pulverized, and by every ploughing a new additional paſture provided. This indeed is true, but we cannot allow that the vegetable food was thereby ſupplied. For what reaſon can be given that a contiguous field, as often ploughed, and equally well pulverized, did not carry ſuch good crops, though ſometimes aſſiſted by manure.

[*] It is in this power of attracting the vegetable food from

air, is enabled to nouriſh a conſtant ſucceſſion of plants.

The earth by culture may be enabled to receive this food in greater plenty. If land

from the air, that the difference betwixt poor and rich ſoils chiefly conſiſts. For if all ſoils had an equal power of attraction, whatever they may have been formerly, they would now be all of one kind; at leaſt all thoſe managed in the ſame manner. If all of them annually receive an equal quantity of vegetable food, and the ſoils, originally rich, have carried greater crops than the ſoils originally poor, it is certain, that, in a courſe of years, there would be no difference betwixt them; the rich ſoils would be reduced to the ſame ſituation with the poor ſoils. To illuſtrate this, two gentlemen, A and B, have each an annuity of *L.* 1000. Beſides this, A has a ſtock of *L.* 9000, and B a ſtock of *L.* 3000. Each, after adding his annual income to his ſtock, ſpends the half every year. Thus, the income of A, which is *L.* 1000, added to his ſtock, which is *L.* 9000, makes *L.* 10,000; the half is *L.* 5000, which he ſpends the firſt year. He has now only a ſtock of *L.* 5000, to which add his annual income, *L.* 1000, makes *L.* 6000; the half is *L.* 3000, which he ſpends the ſecond year. The income of B, which is *L.* 1000, added to his ſtock, which is *L.* 3000, makes *L.* 4000; the half is *L.* 2000, which he ſpends the firſt year. His ſtock is now *L.* 2000, to which add his annual income *L.* 1000, makes *L.* 3000; the half is *L.* 1500, which he ſpends the ſecond year. But though A ſpends more than twice as much as B the firſt year, land is frequently ſtirred and turned over, the vegetable food in the air will have eaſier acceſs, and will be attracted by the earth in greater plenty. When land is allowed to lie long without being ſtirred and turned over, plants grow upon it;

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year, and exactly twice as much the ſecond; yet, on the tenth year, he does not ſpend *L.* 4 more, and on the twentieth not 6 *d.* As *L.* 4 is only the 250th part of *L.* 1000, and 6 *d.* only the 40,000th part; it cannot be ſaid, with reſpect to the common affairs of life, that there is any difference in what the two gentlemen ſpend on the twentieth year, or even on the tenth. Thus then it is evident, that upon the ſuppoſition, that rich and poor ſoils have an equal power of attracting the vegetable food from the air, they would be reduced in a few years to the ſame ſituation. For, like A and B, their annual income is the ſame; like them they ſpend annually, by the crops they carry, a certain proportion of their ſtock; we have called it a half, but the conſequence muſt be the ſame if it is a third or fourth; and therefore, like them, after a courſe of years, will ſpend equally, or carry equal crops. But every perſon knows, that it is not ſo, that there continues a real difference betwixt ſoils under the ſame management; ſome carry richer crops than others, have done ſo for many years paſt, and no perſon doubts, if continued under the ſame management, will do ſo for ever. Now, in what can this difference be ſuppoſed to conſiſt, but in different powers of attraction? To confirm this, it is obſerved, that the earth of rich ſoils is more abſorbent than the earth of ſoils that are poorer.

theſe carry off part of the food, and, by covering the ſurface, prevent, in ſome meaſure, the earth from attracting it from the air. But when land is frequently ſtirred and turned over, the plants that grow upon it, being torn up and covered, are thereby obliged to reſtore the food they have taken, and the ſurface being always kept open, the vegetable food in the air finds eaſy acceſs. Beſides, the ſurface being kept rough and uneven, a greater quantity of the ſoil is thereby expoſed to the influence of the air; and ſome parts being raiſed above others, are fitted for intercepting the vegetable food, as it is driven along by the winds. To this it may be added, that earth, according to the quantity of vegetable food which it has abſorbed, loſes its power of attraction; and therefore, every time that the ſurface is changed, earth, with a ſtronger power of attraction, is preſented to the air, and thereby a greater quantity of vegetable food received, than if the ſame ſurface had remained.

LAND is enabled to receive this food from the air in greater plenty, not only by ſtirring and turning it over, but alſo by mixing with it ſuch bodies as have a power of attracting this food. There are a variety of bodies found from experience to have this power. Among others are lime, chalk, and marles. Theſe, though they do not contain any vegetable food in themſelves, yet communicate this food to land by the power which they have of attracting it from the air.

THAT earth is enabled to receive the vegetable food from the air in greater plenty, by both theſe methods, both by frequently ſtirring and turning it over, and alſo by mixing with it certain manures, is confirmed by obſervation and experience. Fallowing land is a cuſtom that now prevails in many places; and even that kind of land that is moſt free and open in its nature, is found to be rendered more fertile by it.

IT is likewiſe a cuſtom in many places

to uſe lime for a manure, and it is found that the land is enriched by it. As it contains no vegetable food in itſelf, at leaſt no ſalts and oils, which are the ingredients principally wanted; it is obvious, that it muſt increaſe this food, by communicating to the earth a ſtronger power of attraction.

It was likewiſe obſerved, that the vegetable food is increaſed by mixing with the earth ſuch bodies as contain the things of which this food is compounded. There are a variety of bodies that contain theſe things. Among others all kinds of dung, vegetables, and animals. Theſe things being mixed with the earth, and conſumed, all their juices are abſorbed by it, inſtead of flying off into the air. This the experience of all times and all places confirms. Theſe bodies are univerſally uſed as manures, and all kinds of ſoil are rendered more fertile by them.

We before obſerved, that the vegetable food obſerves a conſtant rotation, and is regularly conveyed from the air to the earth, and from the earth to the air. This is the method appointed by the Author of nature, for the preſervation of vegetable life, and for providing a conſtant ſupply of vegetable food, to nouriſh the plants that are continually growing upon the earth. This method is neceſſary to make a juſt diſtribution of this food over all parts of the earth. For if the vegetable food, contained in plants and animals, was not conveyed to the air, before it returned to the earth, it is obvious, that ſome parts of the earth would ſoon be overſtocked with it, and others entirely deprived of it. This method ſeems likewiſe neceſſary to refine this food from the diſagreeable ſmell and taſte which it receives from putrefaction.

THE communicating vegetable food to the earth, by mixing with it ſuch bodies as contain this food, is different from the general method eſtabliſhed by nature; and therefore it is not to be expected, that the food communicated in this way can be ſo perfect, and ſo fit for nouriſhing plants, as when firſt conveyed to the air, and there refined, before it returns to the earth. We know from experience, that it is not ſo perfect, and that ſome vegetables, when nouriſhed by it, have a little of the diſagreeable ſmell and taſte of putrefaction. It is on this account chiefly that dung is baniſhed from the gardens of ſuch as are of delicate and refined palates. But, for the ſame reaſon, to baniſh dung alſo from our fields would be a real diſadvantage. Although it may be proper to uſe as little dung as poſſible, in the culture of thoſe plants, the roots and leaves of which we make uſe of; as the vegetable food in them, eſpecially in the roots, cannot be ſufficiently refined; yet there is not the ſame reaſon to reject the uſe of dung in the culture of thoſe plants whoſe ſeeds only are our food, as the vegetable food, in paſſing through ſo many canals, muſt be refined before it reaches them. Beſides, the advantages ariſing from the greatneſs of the crop produced by the aſſiſtance of dung, do more than overbalance every thing of this kind.

IT may be alleged, that if dung, and the other bodies which contain vegetable food, inſtead of being mixed with the earth, are expoſed to the air, and all their juices allowed to evaporate, there would be no loſs of vegetable food upon the whole: for all of it would return again unto the earth, and with this advantage, that none of it would be communicated to the earth till properly refined. But then, in anſwer to this, it may be obſerved, that although this method of conveying the vegetable food from the earth to the air, and from the air to the earth, is wiſely eſtabliſhed, for making a juſt diſtribution of it upon all parts of the earth; yet it is attended with this diſadvantage, that ſome of it is communicated to places where it can be of very little uſe. Whereas, by communicating immediately to the earth the food contained in dung, and other manures, it is in our power to enrich thoſe places by it, where it can be moſt uſeful.

BESIDES, if we allow the vegetable food its natural rotation, there will always be a greater proportion of it in the air, and in uncorrupted vegetables, than by the preſent practice; and conſequently leſs of it actually employed in vegetation.

BUT, what is worſe, by allowing the vegetable food its natural rotation, when carried off by crops, it will not ſo quickly return to the earth. For by the preſent practice, of communicating the vegetable food to the earth by dung, it may well be ſuppoſed to make two or three rotations, in the time that it would make one; if firſt conveyed to the air, before it returned to the earth. The rotation of the vegetable food, made by mixing dung with the earth, is performed in one year, at leaſt in two. The dung raiſed by the conſumption of a crop, is commonly uſed for the crop immediately following, and moſt of its virtues exhauſted by two crops. But if the vegetable food carried off by a crop is allowed to take its natural courſe, it is ſix or ſeven years before the rotation is performed. It is a long time before the vegetables are putrefied, unleſs ſomething is done to forward this; it is ſome time after this before all their juices are exhaled, and perhaps it is a conſiderable time before they are ſo much condenſed in the air, as to fall down again on the earth. So that if there are two rotations of the vegetable food performed in the way of mixing dung with the earth, for one performed in the natural way, a double quantity of vegetables is actually produced. And therefore we may juſtly conclude, upon the whole, that the gathering dung, and collecting all ſubſtances that contain vegetable food, and mixing them with the earth, is of great importance to promote vegetation *.

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* It is evident from this, that the produce of the earth ſhould be diſpoſed of, and turned into dung, as ſoon as it can be done conveniently; becauſe thereby the rotation of

CHAP. V.

Of the paſture of plants.

IT was obſerved, in chap. 2. that vegetation is promoted, not only by increaſing the food of plants, but alſo by opening the earth, and thereby allowing plants more eaſily to extend their roots in ſearch of their food.

THE place where plants feed is called

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the vegetable food is rendered quicker, and more vegetables actually produced. To illuſtrate this, let us ſuppoſe, that a quantity of the produce of a farm is kept every ſeaſon a year longer than is neceſſary, which, if conſumed, the dung ariſing from it would produce the value of ten pounds. Now, it is obvious, that not only the annualrent of theſe ten pounds is loſt every year, but there is alſo a loſs equal to what the dung ariſing from the conſumption of theſe ten pounds value produces till it is wholly conſumed. Nothing is more obvious, than that if, in any ſeaſon, an extraordinary quantity of dung is uſed, an extraordinary crop will be produced; that this extraordinary crop conſumed will produce dung in proportion, and that this dung will again produce a crop in proportion: and thus the effects of the firſt dung will continue for many years gradually decreaſing. The caſe is the ſame, if, inſtead of keeping the produce of the earth for a year, it is immediately conſumed.

their paſture. It is not abſolutely certain whether the earth is their only paſture. It is not impoſſible but they may receive ſome part of their food immediately from the air. It is certain, that there is ſcarcely a plant that has not ſome parts expoſed immediately to the air, from which, if covered with earth, it will put forth roots. It is not very improbable then, that theſe parts may attract the vegetable food from the air, as the roots do from the earth. To confirm this, it is obſerved, that plants, when beginning to drop their leaves, and to ſhow other ſigns of decay, are recovered by rain ſooner than the water can be ſuppoſed to reach their roots; and ſometimes by moiſt weather, when there is no ſenſible rain.

But though it may be allowed, that plants receive ſome ſmall part of their food immediately from the air, yet it is not to be denied, that they receive the greateſt part of it from the earth. Plants feed in this manner; they ſpread their roots in the earth. Theſe roots are ſo many ny mouths, which receive the vegetable food: they attract and ſuck in the juices and ſmall particles of matter that touch them. The ſtronger the plant is, it puts forth the greater number of roots, and extends them to the greater diſtance. The greater number of roots any plant has, and the farther it extends them, the greater quantity of food it receives.

The roots of plants are tender, they cannot pierce any thing that is very hard. There muſt be cavities, and theſe cavities large enough to allow them to extend themſelves. If there are any pieces of the earth where plants grow, ſo very hard that the roots cannot enter, the plants receive no food from them. If the cavities are larger than the roots, the plants can receive no food, but from the ſides of the cavities that are touched by them. From theſe things it appears, that land may have plenty of vegetable food, and yet a ſmall paſture. The particles of the ſoil may adhere ſo cloſely together, as to make it impoſſible for the roots of plants to ſeparate them; or the ſoil may be of a ſpungy nature, and its pores much larger than the roots that receive the vegetable food. It appears alſo, that the ſoil that has the largeſt paſture is the one that has the greateſt number of cavities, and theſe cavities of ſuch a largeneſs as is beſt adapted to the largeneſs of thoſe roots that receive the vegetable food.

THE ſuperficies by which the cavities are bounded, is what Mr Tull calls the paſture of plants; becauſe the plants puſh their roots into theſe cavities, and feed, as he ſays, upon the ſmall particles of earth which adhere to their ſuperficies. The ſuperficies of the cavities which are in any ſoil, when allowed to reſt, he calls the natural paſture; and the ſuperficies of the cavities made by art he calls the artificial paſture.

C H A P. VI.

Of the methods of enlarging the paſture of plants.

AS the food of plants may be increaſed by art, ſo likewiſe by art their paſture may be enlarged. This is done by ſtirring and turning over the ſoil in which they feed. If the ſoil is ſo hard, and the vacuities ſo ſmall, that the roots of plants cannot enter them, the ſtirring and turning it over enlarges theſe vacuities, and increaſes their number; and thereby renders the ſoil more free and open. For every time that the ſoil is ſtirred, new pores are opened, and ſome of the old ones enlarged. If, in any ſoil, there are pores that have no communication with the reſt, the ſtirring and turning over the ſoil opens this communication. For every time that the ſoil is ſtirred, ſome of the partitions betwixt the pores are broke, and the roots of plants have thereby acceſs to the incloſed pores, and the vegetable food contained in them.

ON the other hand, if the ſoil is ſoft and ſpungy; that is, if the pores and vacuities are too large, the ſtirring and turning over the ſoil breaks the vacuities, makes them ſmaller, and thereby renders the ſoil more firm and ſolid. For every time that the ſoil is ſtirred, the vacuities are cut, ſome particles of earth forced into them, and thereby, in the place of one large vacuity, ſeveral ſmaller ones are formed.

BESIDES, by being frequently ſtirred and turned over, the ſoil is better expoſed to the influence of the air, which has a natural tendency to diſſolve and ſeparate its particles. The natural gravity and attraction of the particles of the ſoil, act directly contrary to the air. The one makes theſe particles continually to adhere to each other, and preſſes them together, till the ſoil becomes as ſolid as its nature will allow, or till it is reduced to its natural paſture; and the other ſeparates theſe particles, and, by degrees, reduces them to atoms. When land is allowed to lie untouched, the natural gravity and attraction of the ſoil, by degrees, prevail, and render the ſoil firmer; and the air, by degrees likewiſe, is prevented from acting: but, when the land is frequently ſtirred and turned over, the air has liberty to penetrate the ſoil, and acts upon a larger quantity of it in the ſeparation of its particles. It is certain, that a piece of the hardeſt ſoil, when expoſed for ſome time to the air, falls down into a powder. In like manner, when land is turned up in hard pieces, and the ſurface left rough and uneven, the air is allowed to have its full influence upon it. But, if left long untouched, the ſurface, by degrees, becomes ſmooth, the air is excluded, and the natural gravity of the ſoil prevails [*].

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[*] DR HOME is of opinion, that the expoſing the ſoil to the influence of the air is the principal advantage of ploughing: "For," ſays he, "ſo groſs an inſtrument," meaning the plough, "would ſeem very unfit to prepare "the earth to enter the capillary veſſels of plants." From this

THAT the paſture of plants is enlarged, both in hard and ſoft land, by ſtirring and turning it over, is confirmed by experience. It is found, that ſtiff clay-land, by being frequently ploughed, becomes more ſoft and free; and that ſoft marſhy land, by being frequently ploughed, becomes more firm and ſolid; and that plants more eaſily find their food in both

this way of expreſſing himſelf, one would imagine that the Doctor is of Mr Tull's opinion, that earth is the food of plants. When ploughing is mentioned as a proper method to enlarge the paſture of plants, it is not ſuppoſed that the plough, by its mechanical operation, ſeparates the particles which are the food of plants, from the other particles of the ſoil, and prepares them for entering their roots; but only that it opens the ſoil, and allows the roots of plants to extend themſelves into all parts of it in ſearch of their food, It muſt be owned indeed, that the mechanical action of the plough is a very improper operation, to prepare the earth to enter the roots of plants; it is probable, that even pounding earth in a mortar would be of little uſe, if true that the particles of earth, before they enter theſe roots, are made ſo ſmall as not to be diſcerned in water. But then this action of the plough is very proper for opening the ſoil, and allowing the roots of plants to extend themſelves. So that though the plough, by its mechanical operation, does not ſeparate the particles that are the food of plants, yet it allows their roots to extend themſelves in ſearch of their food.

theſe kinds of ſoils, when thus reduced, than when in their natural ſituation.

The paſture of plants is alſo enlarged by the application of dung and other manures. For theſe being mixed with the ſoil, raiſe a fermentation, by which the particles of earth being ſeparated from each other, the paſture is thereby enlarged. If the ſoil is hard and ſtiff, the ſeparation of its particles, by fermentation, opens the pores, and renders it more free and open: and, if the ſoil is ſoft and ſpungy, the fermentation ranges its particles in a more regular manner, and thereby renders it more firm and ſolid.

Mr Tull ſuppoſes, that this artificial paſture may be increaſed *in infinitum.* "And this artificial paſture may be in-"creaſed in proportion to the diviſion of "the parts of earth, whereof it is the "ſuperficies, which diviſion may be ma-"thematically infinite. For an atom is "nothing: neither is there a more plain

" impoſſibility in nature, than to reduce
" matter to nothing by diviſion of its
" parts.

" A cube of earth has but ſix feet of
" ſuperficies. Divide this cube, *&c.* and
" ſo is the ſoil diviſible, and this paſture
" increaſible *ad infinitum.*" *Tull's huſb. chap.* 3.—— " Tillage may extend the
" earth's internal ſuperficies, in propor-
" tion to the diviſion of its parts; and,
" as diviſion is infinite, ſo may that ſu-
" perficies be." *Chap.* 5. *Of tillage.*

MR TULL's attachment to his own ſcheme, has carried him too far in this. To aſſert that an atom is nothing, is perhaps aſſerting too much. It is probable, that there are a certain number of original ſubſtances, and that theſe different ſubſtances are compounded of particles which no operation can leſſen, till their natures are changed. The ſtrongeſt fire cannot alter the form of the particles of metals, ſo as to leſſen their pores, neither has the heavieſt weight the ſmalleſt influence; and yet that there are pores in theſe metals, is certain; for one is ſpecifically heavier than another. Is it not reaſonable to infer from this, that theſe metals are compounded of particles, the form and magnitude of which cannot be changed? With equal reaſon, we may infer the ſame thing of earth; that it is compounded of particles, which cannot be altered; which may be ſeparated, when they adhere to each other, but cannot be divided.

But ſuppoſe an atom is nothing, yet certainly every ſoil is compounded of particles, many of which, though capable of diviſion, will never be divided by the mechanical action of the plough. It is obvious, that every ſoil is compounded of different ſubſtances, different from each other, and compounded of different particles. Although ſome of theſe ſubſtances may be divided into very minute particles, yet perhaps others of them will not allow this. It is certain, that ſome of them are of ſuch a nature, and have their particles ſo firmly adhering together, that they never can be ſeparated by tillage. Small pieces of ſtone, ſand, metals, all vitrified ſubſtances, the plough can have no influence upon; and yet almoſt every ſoil has ſome of theſe in its compoſition; ſo that earth, employed in vegetation, with reſpect to any diviſion that can be made by the mechanical operation of the plough, may be ſaid to be compounded of atoms; and may be pulverized in ſuch a manner, that the plough can make no alteration in its pores, more than it can make in the pores of water. Before earth is thoroughly pulverized, it is certain, that every time that it is broken by tillage, there muſt ariſe a new ſuperficies of broken parts, that never exiſted before. But this new ſuperficies cannot be large. For the earth always opens before the plough, at thoſe places where the adherence of the particles is weakeſt; that is, where the pores are moſt numerous, and the partitions betwixt them moſt eaſily broken, while the hard pieces are moved whole. It muſt be allowed likewiſe, that, at every ploughing, the external ſurface is turned into an internal ſuperficies, and a part of the internal ſuperficies into the external ſurface; which makes a change in the vegetable paſture. But this change cannot be great. For the external ſurface bears but a ſmall proportion to the extent of the internal ſuperficies: and beſides, the greateſt part of the external ſurface, perhaps the whole, has been frequently a part of the internal ſuperficies before.

CHAP. VII.

Of the methods of preparing the vegetable food for the nouriſhment of plants.

IT was before obſerved, that vegetation is promoted, not only by communicating to the earth the food of plants, and enlarging their paſture, but alſo by diſſolving the vegetable food, and fitting it for entering their roots.

The vegetable food is in a variety of different forms. Sometimes there is plenty of it in land, but in ſuch a form as renders it uſeleſs, ſometimes hurtful. This is the caſe with land, which is full of uncorrupted vegetables. When treating of the food of plants, we had occaſion to obſerve, that vegetables are food to vegetables; and that, to fit them for this, it is neceſſary that their parts be ſeparated by corruption. Now, if any land is full of vegetables, it may be ſaid to contain vegetable food: and if theſe vegetables are undiſſolved, it may be ſaid, that this vegetable food is in a ſtate that renders it uſeleſs; and if they are not only undiſſolved, but alive, and draw nouriſhment from the land to ſupport them, it may be ſaid, that the vegetable food is in ſuch a ſituation as renders it hurtful. When the ſoil has in it a great mixture of moſs, which is now allowed to be an uncorrupted vegetable, it may be ſaid to have vegetable food in an uſeleſs ſtate; and when it is much infeſted with weeds, it may be ſaid to have vegetable food in a hurtful ſtate. To prepare the vegetable food in ſuch land for the nouriſhment of plants, the land muſt be managed in ſuch a manner, as to reduce the vegetables to a ſtate of putrefaction. The ſtirring and turning over the ſoil frequently will have ſome influence; for thereby the weeds are deſtroyed, and they muſt be deſtroyed before they will putrefy *.

BUT that which has the greateſt influence, is the application of ſuch bodies as are found to have a power of diſſolving vegetable ſubſtances. Lime is the principal thing for this purpoſe, as will be ſhown when its nature and operation is treated of.

BUT land may likewiſe be ſaid to contain vegetable food, in a ſtate that renders it uſeleſs, when it contains oils, but theſe oils undiſſolved. We have had occaſion formerly to obſerve, that oil is one of the principal ingredients of the vegetable food, and that, to fit it for entering the roots of plants, it is neceſſary that it be diſſolved by ſalt. We have likewiſe obſerved, that the operation of ſome kinds of ma-

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* See chap. 12. and 13. of this book.

nures, ſhows that ſome land, in this ſituation, contains a greater proportion of oil than its ſalt is capable to diſſolve. To prepare the vegetable food in ſuch land, for the nouriſhment of plants, it is neceſſary to provide ſalt to diſſolve its oils. The changing the ſurface, and expoſing the ſoil frequently to the influence of the air, in the winter and ſpring, has ſome effect; for, in theſe ſeaſons, the ſalts in the air are moſt prevalent. But the application of lime, and the other manures that ferment moſt violently with acids, is the moſt proper thing for this purpoſe. For, by this fermentation, the ſalt wanted is actually produced *.

CHAP. VIII.

Of the impediments to vegetation.

IT is not enough that we know how to promote vegetation, by increaſing the food of plants, enlarging their paſture, and fitting the vegetable food for their nouriſhment: it is neceſſary likewiſe to know, what impediments there are to it, and how theſe impediments may be removed.

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* See book 3. chap. 6. 8. 9. and 10.

AMONG the impediments to vegetation are commonly reckoned, weeds, too much water, diſeaſes of plants, and bad ſeed. The impediment ariſing from bad ſeed can eaſily be removed; the diſeaſes of plants we may poſſibly do ſomething to prevent, but we can do little to remove; and therefore it is needleſs to inſiſt upon theſe. Beſides, they fall more naturally to be conſidered when the culture of particular plants is treated of. The impediments ariſing from weeds and too much water, fall naturally to be conſidered in this place.

IT is perhaps neceſſary to aſſign the reaſon, why weeds and draining of land are, contrary to the ordinary practice, treated of in this place. The generality of writers on huſbandry, or agriculture, who have attempted a regular method, firſt treat of ſoils; next of manures; then of tillage, and the culture of particular plants; and, laſt of all, of the different impediments to vegetation. We have obſerved a different method: we have begun with the principles of vegetation, and have treated of the impediments to it, and the ways of removing theſe impediments, in this firſt book. And the reaſon is, that when we treat of tillage, in the ſecond book, we may have all the different deſigns of it in view. Tillage is deſigned, not only to increaſe the food of plants, and enlarge their paſture; but alſo to deſtroy weeds, and drain land by laying it up in proper ridges. Now, in treating of tillage, it is neceſſary to have in our view the deſtroying of weeds, and draining of land; as well as the increaſing the food of plants, and enlarging their paſture: and therefore it is neceſſary to mention theſe impediments to vegetation, and the methods of removing them, before tillage is treated of, with a view to ſerve theſe purpoſes.

CHAP. IX.

Of weeds, as an impediment to vegetation.

ALL plants are not uſeful to man. Some of them are not only uſeleſs; they are alſo noxious. Plants of this kind are called weeds. Botaniſts deny, that there is ſuch a thing as an uſeleſs plant in nature, which indeed is true according to their meaning. But, to prevent all diſputes about this, we ſhall, with Mr Tull, conſider as weeds all plants that grow upon a field, of a different kind from what are intended by the farmer. There is not a field where we do not find ſome of theſe; they grow in the greateſt plenty on the richeſt ſoils.

WEEDS will appear impediments to vegetation, if we conſider theſe things following.

THEY rob the plants we deſire to cultivate of their food; they prevent theſe plants from branching out from the root, and they leſſen the vegetable paſture in the land, where they are ſuffered to grow.

WEEDS are nouriſhed by the ſame food that would nouriſh uſeful plants; and therefore, when allowed to grow along with them, muſt rob them of part of their food. Although it is allowed, that the food of all plants is not exactly of the ſame kind; yet as plants ſuck in whatever juices, or ſmall particles of matter are touched by their roots, it may be juſtly ſaid, that all kinds deprive the earth of that vegetable food which would nouriſh others. Experience convinces the farmer of the truth of this: for he finds, that his crop is bad in proportion to the quantity and kinds of weeds with which his land is infeſted.

WEEDS cover the ſurface of the land on which they grow, and thereby, confining the plants we deſire to cultivate, prevent them from branching out from the root. For all plants, when confined by others at their ſides, inſtead of branching out, as ſome of them are inclined to do, make vigorous efforts to get above thoſe by whom they are confined.

Some perſons have attempted to ſhow, that corn never wants room to grow; and that it is the want of food alone which makes ſome plants decay, when they are ſet too thick. If this is true, weeds can do no harm to plants, by covering the ſurface, and confining them while they grow. But let a perſon caſt his eyes upon a plantation of any kind, and he will immediately obſerve, that where the plants are placed very near to each other, they ſtretch out chiefly to the length; and where they are placed at a greater diſtance, they grow not ſo much to the length, but more to the thickneſs, and branch out on all ſides. So that the proportion of nouriſhment which the plants receive, makes them grow either to the length principally, or to the thickneſs, and branch out, according as they are placed near, or at a diſtance from each other.

The ſame thing happens, when there are many weeds growing amongſt corn. Some fields are ſo much infeſted with weeds, that, though no grain is ſown, the plants come up very thick. This obliges the farmer to give plenty of ſeed. In conſequence of which the ſurface is quite covered; and the plants of corn being confined by the weeds, inſtead of branching out from the root, and producing two or more ſtalks, as they are naturally diſpoſed to do, puſh up one ſtalk only; that ſo they may the more eaſily get above their rivals. The proportion of nouriſhment which they receive, makes them grow to the length, inſtead of branching out from the roots; makes them produce one ſtalk and ear only, inſtead of many. Experience confirms the truth of this. When land is rich, and at the ſame time much infeſted with weeds, the plants of corn grow tall enough; but ſeldom have more than one ſtalk.

SOME kinds of weeds have great numbers of ſmall roots, which they extend to a great diſtance. Theſe roots bind the ſoil in ſuch a manner, as to leſſen the vegetable paſture; or rather, make it very difficult to enlarge it by tillage. It may be obſerved, that when a field is much infeſted with quickening graſs, the ſoil is ſo firmly bound together by the roots, that it is not poſſible to pulverize it. When ploughed, the earth of the furrow is turned over whole, and the harrows ſcarcely make any impreſſion upon it.

IT is of great importance therefore to know, how to deſtroy theſe uſeleſs and noxious plants; that ſo all the vegetable food in the ſoil may be applied to the nouriſhment of the uſeful plants we deſire to cultivate; that theſe uſeful plants may have room to extend themſelves, and branch from the root on all ſides; and that the vegetable paſture, which, by the rain that falls, and the natural weight of the ſoil, is always leſſening, may be the more eaſily enlarged.

CHAP. X.

Of the different kinds of weeds.

PLANTS are commonly divided into two ſorts; annuals, that is, ſuch as in one year come to perfection, carry ſeed, and die; and perennials, that is, ſuch as continue in life for more years than one. Annual plants are almoſt all propagated by the ſeed. Perennials are propagated, ſome by the ſeed, others by the root, and a third ſort both by the ſeed and root.

WEEDS may be divided in the ſame manner, into annuals and perennials. But, in treating of the methods of deſtroying them, we will be better underſtood, if they are divided into theſe two ſorts; weeds that are propagated by the ſeed, and weeds that are propagated by the root. It is needleſs to conſider the weeds that are propagated both by the ſeed and the root, as a third ſort. For when their ſeeds infeſt the land, they muſt be treated as weeds that are propagated by the ſeed; and, when their roots infeſt the land, they muſt be treated as weeds that are propagated by the root. It is neceſſary, however, to divide weeds into theſe two ſorts, into which we have divided them: for, in ſome caſes, that kind of management proper for diſcouraging the one ſort, tends to encourage the growth of the other.

But, beſides theſe two ſorts of weeds mentioned, it will not be improper that we likewiſe take notice of thoſe ſhrubs by which ſome land is greatly infeſted. Theſe, though they are not commonly reckoned in the claſs of weeds, and though ſome of them may have their particular uſes; yet, as they are plants different from what the farmer deſires to cultivate in his fields, they fall under the definition which we have given of weeds, and ſhall be reckoned by us a third claſs.

CHAP. XI.

Of the methods of deſtroying weeds.

THE deſtroying of weeds is certainly one of the moſt important parts of agriculture. By allowing them to grow, we allow the land, as was formerly obſerved, to be robbed of its vegetable food, and its vegetable paſture to be greatly leſſened.

It may be inquired, What becomes of this vegetable food of which they rob the land? It is either conveyed to the air, and ſent to enrich other land, or it is turned into a form that renders it deſtructive.

When weeds wither and putrefy above ground, the ſalts and oils which they contain, and of which they deprived the land on which they grew, become volatile and fly off into the air, and leave little more than their earth remaining.

When weeds carry ſeed, and ſhed it upon the land, and when the roots, by the nouriſhment they receive, are enlarged and extended; the vegetable food, of which they have deprived the land, is turned into a form that renders it deſtructive, into ſeeds and roots, by which the land is further exhauſted.

The ſeeds and roots of weeds, though deſtructive to uſeful plants, by robbing them of their food, yet they contain vegetable food in themſelves; and, when the ſeeds are picked up by birds, and the roots eaten by animals, the vegetable food is carried off. But, if theſe weeds are deſtroyed, and reduced to a ſtate of corruption, the vegetable food, which they have taken from the land, and rendered deſtructive, is reſtored to it, and becomes beneficial: ſo that land that is poor, and unfit for carrying crops of uſeful plants, by being full of weeds, may be made rich and fertile, by deſtroying them.

From theſe things, it appears, that the

deſtroying of weeds is one of the moſt important parts of agriculture. As it is important, ſo likewiſe it is difficult.

THERE is ſcarcely a field, in which we will not obſerve weeds of the two firſt kinds mentioned; of the kind that is propagated by the ſeed, and the kind that is propagated by the root. Some of theſe, perhaps, it may be eaſy to deſtroy, as they are foreigners, and not adapted to the ſoil; but others of them being natural to the ſoil, in that kind of it that is moſt proper for them, it may be expected, not only that it will be very difficult to deſtroy them, but alſo, that, by the culture given to the land, they will thrive wonderfully, carry great crops of ſeed, and multiply and extend their roots. As the deſtruction of weeds is then ſo important and difficult, it is a work that muſt be particularly attended to.

WEEDS have been divided into three ſorts. To deſtroy theſe different ſorts, different management is required. It is neceſſary therefore to treat of them ſeparately.

CHAP. XII.

Of the methods of deſtroying weeds that are propagated by the ſeed.

WEEDS are very different in their natures. The ſeeds of ſome of them will putrefy in a few years, if they lie moiſt in the earth, and are prevented from vegetating. But the ſeeds of others will lie many years in this ſituation, without having their vegetative power deſtroyed. * This we know from experience. Land infeſted with different kinds of weeds, has been frequently thrown out into graſs, and allowed to remain in that ſituation for ſome years. Though allowed to lie only a few years, ſome kinds of weeds

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* Of the firſt ſort are the charlock and poppies, of the ſecond ſort is the wild oat.

It is uncertain how long ſome ſeeds may be preſerved without loſing their vegetative power. 'Tis ſaid, that, two months weeds are found to be deſtroyed, when the land is broke up again; but, though it lie twenty years, ſome other kinds are found in as great plenty as before.

THE firſt ſort may be deſtroyed by turning the land infeſted with them, from tillage into graſs, and allowing it to remain in that ſituation for five or ſix years.

BOTH ſorts may be deſtroyed by bringing the ſeeds to vegetate, and then tearing up the young plants. Seeds will not vegetate without air. Some require a greater proportion, and ſome a ſmaller. The ſmall ſeeds will not vegetate without a very great proportion of it. It may be obſerved, in fallowing land which is full of weeds, that great numbers of them appear after every ploughing. This ſhows, that ſome of the ſeeds had not a ſufficient quantity of air, in their former ſituation, to make them vegetate. Now, to give

months after the great fire in London, a ſpecies of *eriſimum* appeared in great plenty, where houſes had been for a thouſand years.

theſe ſmall ſeeds the proportion of air neceſſary for them, they muſt be brought near the ſurface, and the earth about them rendered free and open. If the land is frequently ſtirred and turned over, both theſe will be done. For every time the land is ſtirred and turned over, ſome ſeeds, that before lay deep, are brought near the ſurface, and the earth about them alſo rendered free and open: and, beſides, the plants that have appeared are thereby torn up and deſtroyed.

EVERY farmer that practiſes ſummer-fallowing, is now fully convinced of the truth of this. For he obſerves, when the ſeaſon is favourable, and his fallow is well and frequently ploughed and harrowed, and time allowed betwixt every ploughing and harrowing for the weeds to vegetate, that his land, for ſeveral years, is not ſo much infeſted with weeds as before.

IT has been obſerved, that ſeeds will not vegetate without air, and that to give the ſmaller kinds the quantity which they require, they muſt be brought near the ſurface, and the earth around them rendered free and open. It is neceſſary likewiſe to obſerve, that water is as requiſite to promote vegetation as air; and that the bringing ſeeds near the ſurface, and rendering the earth free and open around them, as it ſupplies them with air, tends to deprive them of water. In the performance therefore of thoſe operations by which the land is ſtirred and turned over, to promote the vegetation of the ſmall ſeeds, great care muſt be taken to preſerve the ſap, as much as is poſſible. This will be done, if, in ſtirring the land, the ſurface is made ſmooth and plain. It is obvious, that, when the ſurface is rough and uneven, the drought has eaſy acceſs; but, when it is ſmooth and plain, the winds have leſs influence, and the ſap is better preſerved. Every farmer will obſerve, that, in dry weather, when land is allowed to lie ſome time after it has been ploughed, without being harrowed, the drought has eaſy acceſs, the ſap is exhaled, and the ſeeds in it, though near the ſurface,

face, and the earth around them free and open; yet, being deprived of water, are prevented from vegetating: whereas, when the land is harrowed immediately after it is ploughed, the ſap is preſerved, and the ſeeds ſpring up. Hence the cuſtom of ſowing barley immediately after the plough. Barley is commonly ſown in a dry ſeaſon; and therefore the land is not allowed to lie long after it is ploughed, leſt the ſap ſhould be exhaled; but is immediately ſown and harrowed, by which the ſap is preſerved.

THE vegetation of ſeeds in land is promoted, not only by ſtirring and turning over the land, but alſo by the application of dung and ſome other manures. Dung raiſes a fermentation; this opens the pores of the ſoil, allows the air to reach the ſeeds, and gives them liberty to put forth their roots. If dung, therefore, is laid upon land infeſted with weeds, and the land carefully ſtirred and turned over ſeveral times, all the ſeeds in it, by degrees, will be brought to vegetate; and thus the weeds will be deſtroyed.

IT muſt be owned, that this practice, though proper for deſtroying weeds, may, in ſome caſes, deſtroy ſome of the virtues of the dung, before it is applied to promote the vegetation of the uſeful plants we deſign to cultivate. Dung promotes vegetation, by producing a fermentation in the ſoil upon which it is laid; and, by this fermentation, ſeparating its particles. If this fermentation is, in a great meaſure, over before ſeed is ſown, the natural weight of the ſoil, making it ſubſide, will render the vegetable paſture, while the plants are growing, much leſs than it would have been, if the dung had not been ſo ſoon laid on: and more harm may be done by this, than advantage gained by deſtroying the weeds. But, though it may be improper to follow this method, when ſeed cannot be ſown for a conſiderable time after the dung is laid on, as is the caſe ſometimes when ſummer-barley is ſown on fallow; yet it may anſwer very well, when ſeed is to be ſown ſoon after, as is the caſe when wheat is ſown. The advantages ariſing from the deſtruction of the weeds, though not in the firſt caſe, yet in the laſt, may probably do more than overbalance the loſs ariſing from ſome part of the ſtrength of the dung being exhauſted before ſeed is ſown.

It may, perhaps, be thought a little ſurpriſing, that dung ſhould be propoſed as a means of deſtroying weeds, when it is univerſally conſidered as a great encourager of them. It is certain, that the laying dung upon land makes more weeds appear, than otherwiſe would do. If the ſeeds of theſe weeds are in the dung, it muſt be owned, that it increaſes, and not diminiſhes their number. But, if the ſeeds are in the land, and the dung only makes them vegetate, it becomes a proper means of deſtroying them.

It ſeems to be the general opinion, that the great plenty of weeds that appear on land after it is dunged, are produced from ſeeds mixed with the dung. But there are ſome reaſons to believe that this is a miſtake.

IT is obſerved, that dung produces weeds, when it is taken from a dunghill, ſo much heated as to deſtroy the vegetative power of any ſeed.

IT is obſerved likewiſe, that the ſame dung produces weeds, according to the nature of the land on which it is laid. It often happens, that dung carried from a town is laid upon different ſoils; and it is certain, that this dung does not produce the ſame kind of weeds on all ſoils, which it would do, if the weeds aroſe from ſeeds mixed with it; but always produces the weeds, with which the ſoil upon which it is laid is naturally infeſted.

THESE obſervations make it very probable, that the great quantity of weeds produced by dung, is entirely owing to the fermentation occaſioned by the dung;

by which almoſt all the ſeeds near the ſurface, receiving a proper quantity of air, are thereby brought to vegetate.

To this it may be objected, That ſuch numbers of weeds do not appear upon land that is new marled, as upon land that is dunged. But, in anſwer to this, let it be obſerved, that a great quantity of marle is laid on, and in large pieces, and that it is ploughed in with a ſhallow furrow: And therefore, though a fermentation may be raiſed, yet the undiſſolved marle prevents a great part of the ſoil from being expoſed to the air, in ſuch a manner as to make the ſeeds in it vegetate; and alſo occaſions ſuch a hollowneſs, that, after the ſeeds begin to vegetate, ſuch of the plants as are tender (and ſeveral ſorts of them are not ſo hardy as corn) are eaſily deſtroyed by drought or froſt.

Before we leave this article, it is neceſſary to obſerve, that the ſeeds of ſome weeds, particularly the different ſpecies of the thiſtle, are carried to a conſiderable diſtance by the wind; and where any earth is thrown up in ſuch a manner as to intangle them, as at the root of a hedge, or ſide of a ditch, there they appear in great plenty. It is ſurpriſing, that many farmers allow them to grow there undiſturbed: the conſequence of which is, that their ſeeds are carried in great plenty into the adjacent fields, and thereby great damage is done; which might have been prevented by cutting them down, at a ſmall expenſe, before their ſeeds were ripened.

CHAP. XIII.

Of the methods of deſtroying weeds that are propagated by the root.

THERE are many different kinds of weeds propagated by the root, and theſe of very different natures. Some of them infeſt the land that is in tillage, and others the land that is in graſs. Any perſon may ſatisfy himſelf of this, by inſpecting our fields. The farmer is very ſenſible of it: he knows that ſome kinds of weeds flouriſh and increaſe in his land, while in tillage, if he does not take all pains to diſcourage them; and when he lays down his land in graſs, other kinds that did not appear before, ſoon diſcover themſelves; and, if undiſturbed, continue to increaſe, while the land remains in that ſituation [*].

THE firſt ſort, it ſeems, have ſuch a tender blade, and ſuch tender roots, that they cannot pierce earth that is hard; but are of a kind that increaſe very faſt, when the ſoil is free and open.

THE ſecond ſort have the blade and roots ſo ſtrong, that there is ſcarcely any ſoil that, of itſelf, will become ſo hard and ſtiff, as to prevent them from making their way through it; but are of ſuch a nature, as to be eaſily torn up, when the land is free and open; and do not eaſily ſtrike root again when torn up.

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[*] Of the firſt ſort is the quickening-graſs, or couch-graſs. Of the ſecond ſort are the yellow rag-weed, the mountain-thiſtle, *&c.*

THE natures of theſe weeds point out methods of deſtroying them.

THE firſt ſort, as they chiefly infeſt land in tillage, may be deſtroyed by turning the land from tillage into graſs, and allowing it to remain for ſome years in that ſituation. This is confirmed by experience. Land over-run with quickening-graſs, and other root-weeds of the ſame kind, is frequently laid down in graſs, and allowed to continue for ſome years without being ploughed. This land, when broke up again, if allowed to lie in graſs for ſix or ſeven years, is found to be clean, and the roots of the weeds deſtroyed.

THE number of years neceſſary for deſtroying the roots, depends upon the nature of the ſoil. If the ſoil is naturally hard and ſtiff, it is the ſooner brought to ſuch a ſituation, as to prevent the roots and blades of the weeds from piercing it.

But, if it is naturally ſoft and ſpungy, it takes a longer time before it is brought to that ſituation. For while the blade, or roots of the weeds, can pierce the ſoil, their vegetation is not prevented. In ſome ſoils, it is ſix or ſeven years before the roots of the quickening-graſs are deſtroyed.

THE number of years found neceſſary for deſtroying theſe root-weeds, has, no doubt, been partly the occaſion of eſtabliſhing the practice commonly obſerved in treating outfield land *. Three crops of corn are taken, and then the land is allowed to lie ſix years in graſs, or lea. At the end of theſe, the farmer ſuppoſes that the lea is come to maturity, and fit again for being ploughed. When it is only

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* The arable land in Scotland is divided into infield and outfield. The infield is the land upon which, from time immemorial, the whole dung made in the farm has been laid. Till of late it was always kept in tillage, and is ſo ſtill in many places. The outfield is the land upon which no dung is laid, excepting that the ſheep and cattle are ſometimes folded upon it. It is ſometimes in tillage, and ſometimes lying lea.

ly two or three years old, it is called, in ſome parts of the country, *calf-lea*; and, if ploughed at that age, is commonly very full of roots.

THE ſowing land with graſs-ſeeds, inſtead of turning it out into lea, deſtroys the roots of theſe weeds ſome years ſooner. For thereby a ſward being brought immediately upon the ſurface, the land becomes firm, the blades of the weeds are unable to pierce it, and the roots are deprived of air. Ryegraſs-ſeed, or the common hay-ſeed, is the moſt proper for this. For the plants ariſing from theſe, ſoon cover the ſurface, and, by the number and ſmalneſs of their roots, bind the ſoil. Clover, particularly the broad clover, is improper. For the roots of it being large, they open the ſoil in growing and extending themſelves; and thereby prevent it from arriving at that degree of firmneſs, neceſſary for deſtroying the weeds, ſo ſoon, as if no graſs-ſeeds are ſown, but the land immediately turned into lea.

The ſecond ſort may be deſtroyed by turning the land infeſted with them, from graſs into tillage. And it is not neceſſary to continue it long in this ſituation: for the weeds commonly diſappear after the firſt ploughing.

But as it may be inconvenient to turn a field infeſted with weeds, from graſs into tillage, or from tillage into graſs; it is neceſſary to conſider, if there are any methods of deſtroying theſe weeds, without altering the ſituation of the land.

When land in tillage is infeſted with weeds, they may be deſtroyed by frequently ſtirring and turning it over in dry weather. For the weeds being removed out of their place, the drought prevents them from ſtriking root again. The ſtirring the land in wet weather, is rather hurtful than beneficial. For though the roots of the weeds are removed from their place, yet the weeds themſelves are only tranſplanted. If the land is wet, they ſoon ſtrike root again; and the quickening-graſs, in particular, having its paſture enlarged, makes quicker progreſs than ever. But, if the land is dry, the weeds do not ſo eaſily ſtrike root again; or, if ſome of them ſhould ſtrike root, they continue for ſome time in a languiſhing condition, and if removed out of their place, while in this condition, are eaſily deſtroyed by the drought. If land then is frequently ſtirred and turned over, by degrees all the weeds will be deſtroyed: for, by every ſtirring or ploughing, ſuch of them as are in a languiſhing condition are deſtroyed, while thoſe that are ſtrong and vigorous are weakened.

WHEN land is to be freed from ſeed-weeds, it cannot be made too fine, nor the ſurface too ſmooth. For the more perfectly theſe are done, the greater number of ſeeds are brought to vegetate. But, when land is to be freed from root-weeds, it cannot be turned up in too large pieces, nor the ſurface left too rough: for the larger the pieces, and the rougher the ſurface, the drought has the eaſier acceſs, and the roots are the more effectually deſtroyed.

When land in graſs is infeſted with weeds, and it is inconvenient to turn it into tillage, the weeds themſelves muſt be pulled up by the root, or frequently cut; which are the only ways of deſtroying them.

Some perſons aſſert, that ſheep are very fond of the yellow rag-weed, by which light land, when laid out in graſs, is very much infeſted. If this is true, the putting ſheep to paſture upon this graſs, for a ſeaſon or two, will effectually deſtroy this weed. This may be the more ſafely recommended, as the trial, though it does not ſucceed, cannot be attended with any danger or loſs.

Some land, after being a few years in graſs, is liable to be over-run with fog. This, 'tis ſuppoſed, is owing to the ſoil becoming ſoft and ſpungy near the ſurface. If this is the caſe, rolling, which makes the ſurface firm, will be of ſome uſe to deſtroy this pernicious weed. It may be obſerved, that, when there is a foot-path through a graſs-field over-run with fog, not ſo much frequented as to break the turf, the graſs upon the path is clean, without any mixture of fog.

THERE is a third ſort of weeds found to infeſt both the land that is in tillage, and the land that is in graſs. This ſort have not only the blade and roots very ſtrong, ſo as to be able to pierce the ſoil, though hard, but alſo are of ſuch a nature, as makes it difficult to tear them up; or have their roots of ſuch a kind, that they may be divided into a great number of plants *.

THESE weeds cannot be deſtroyed, either by turning the land infeſted with them, from tillage into graſs, or from graſs into tillage. But they may be deſtroyed by the methods mentioned, when

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* OF this ſort are ſome ſpecies of the thiſtle, and what the ploughmen call *ſitfaſts*.

the ſituation of the land is not changed. If the land is in graſs, they may be deſtroyed by digging them out, or by frequently cutting them. And, if the land is in tillage, they may be deſtroyed by frequently ſtirring and turning it over in dry weather. This work muſt be performed with ploughs properly made for cutting their roots. This kind of weeds puſh their roots very far down, and their roots are ſo tough and hard, that our common ploughs ſeldom break them. If there are any ſtones in the land, they puſh their roots among the ſtones; and, in ſuch places, the plough not having freedom to act, they continue undiſturbed. In this land too the plough, moſt proper for cutting theſe roots, cannot go with ſafety. But if the ſtones are dug out, and the land ploughed with a broad pointed ſoke (ſhare), the roots, by degrees, will be cut, and the weeds deſtroyed *.

Besides theſe three ſorts of weeds

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* See book 2. chap. 7.

mentioned, there is a fourth that chiefly infeſts land that is wet. Frequent cutting, and even digging out by the root, have been tried to deſtroy them, but to no purpoſe. They are not to be ſeen on dry land, and, when on land only inclining to be wet, appear very weak. This points out draining to be the proper method of deſtroying them, which indeed does it effectually.

WE ſhall conclude this article with obſerving, that all kinds of root-weeds, and many kinds of the ſeeds of weeds, may be deſtroyed by depriving them of air. For air is neceſſary not only to the vegetation, but alſo to the life of every plant.

WHEN land is in tillage, the weeds may be deprived of air, either by burying them deep in the earth, or covering the ſurface. Trenching does the one, and a good crop of peaſe, potatoes, or any other plants that lie thick on the ſurface, does the other.

Fog, by which ſome lands in graſs are much infeſted, 'tis ſaid, may be deſtroyed in the ſame manner. The method propoſed is this. The graſs muſt be kept from the month of May to the month of December, for winter-paſturing, and next ſeaſon muſt be preſerved for a crop of hay. The fog, by this management, being covered for two ſeaſons by the graſs, is thereby deſtroyed.

C H A P. XIV.

Of the methods of deſtroying the ſhrubs, which are conſidered as a third claſs of weeds.

There are ſeveral ſhrubs that grow naturally upon our land in Scotland. Some of the land is indeed ſo poor, that, though cleaned of them, it would not, without improvement, carry any plants of greater value; and the means of improvement yet known, are at too great a diſtance to bear the expenſe of carrying. But the whole land is not of this kind: ſome of theſe ſhrubs infeſt rich land, which, with ordinary dreſſings, when cleared of them, carries plentiful crops of uſeful plants. The chief of them are the whin (furze), the broom, and the bramble. Theſe ſhrubs are not indeed uſeleſs: the whin, in particular, is of value; but the land upon which they grow, may frequently, however, be employed to greater advantage; which makes it neceſſary to inquire into the moſt proper methods of deſtroying them.

CHAP. XV.

Of the methods of deſtroying whins.

WHEN a field is infeſted with whins, nothing can be done till it is cleared of them. The moſt proper way is to dig them out. If the whins are old and ſtrong, cutting is not ſo proper: for if they are only cut, it will ſcarcely be poſſible to plough the field; and it is vain to attempt to continue a field in graſs, after it is cleared of whins. For it is ſcarcely poſſible to dig out the whole roots; and thoſe that are left, will immediately ſpring up. Beſides, there are ſo many ſeeds, that have fallen from time to time, and the places covered with the whins having no ſward of graſs upon them, it may be expected, that they will appear, in a ſhort time, in greater plenty than ever. This makes it neceſſary to bring the land, after it is cleared of them, from graſs into tillage. While the land is continued in tillage, no whins are diſcovered; but if it is thrown again into graſs, in a few years they appear in as great numbers as before. Now, the principal thing to be conſidered, is this; how the whins may be deſtroyed ſo effectually, as to prevent them from over-running a field formerly infeſted with them, when it is turned from tillage into graſs.

It is propoſed by ſome, to cut the plants frequently while young. This, no doubt, will weaken the plants; but it is very uncertain, if it will effectually deſtroy them. Pulling them up is certainly a better way; and this, unleſs where they are very thick, is neither troubleſome nor expenſive. If a perſon takes a view of a field formerly infeſted with whins, on the ſecond year after it has been laid out into graſs, he will obſerve the young plants ſprung up; and, if the land is moiſt, he will obſerve, upon trial, that they may be pulled up without any difficulty, even by young boys. If this method is taken, and any of the plants ſo young, as not to be obſerved at firſt going over, they will appear in the end of the ſeaſon, or the beginning of the next; and, even then, will not have taken ſuch deep root, as to render it very difficult to pull them up. 'Tis probable, that, in a field that has long been infeſted with whins, there will be a great number of ſeeds, many of which, from their deepneſs in the earth, will not vegetate, when the land is firſt turned from tillage into graſs; but ſome of them, being nearer the ſurface, the next time that this is done will probably appear. This makes it neceſſary to repeat this work of pulling, as often as the land is turned from tillage into graſs. But then it may be obſerved, that it will become every time leſs troubleſome and expenſive.

But, beſides theſe methods mentioned, there is a ſcheme of management, which, it is probable, in a courſe of years, will effectually deſtroy whins. It is certain, that the ſeeds of whins will not vegetate, unleſs they are allowed to lie in the earth for a conſiderable time undiſturbed. It may perhaps be difficult to aſſign the reaſon of this; but the thing itſelf is certain. While land is kept in tillage, though there may be plenty of whin-ſeeds in it, yet they never vegetate. The plants do not even appear, till two years after the land has been allowed to reſt. If any perſon will take the trouble to obſerve the young plants at their firſt appearance, he will be convinced, that all of them ariſe from ſeed, and not from any roots that have been left in the land, and not deſtroyed by the ploughing. Now, if a ſcheme of management is followed, by which the land is turned from tillage into graſs, and from graſs into tillage alternately, remaining in each for a few years; the whins, by degrees, will be wholly deſtroyed. For every time that the land is turned into graſs, the whin-ſeeds near the ſurface will vegetate; and every time that the land is brought into tillage, the young plants will be deſtroyed.

'TIS acknowledged, that, in ſome places, a practice like this is commonly followed; the land is for ſome years in tillage, and for ſome years in graſs; and yet continues to be as much infeſted with whins as ever. The reaſon of this is obvious. This land is what is called *outfield land*; that is, land not improved, and that has received but little manure. When brought into tillage, three or four crops exhauſt it; and it muſt lie, at leaſt, ſix, perhaps many more years in graſs, to recover, before it is worth while to bring it again into tillage. During this time, the whins grow ſo large as to carry ſeed; and the ſeed which they ſhed, being preſerved while the land is in tillage, ſpring up when it is laid down again into graſs. So that, by this method, upon the whole, the quantity of ſeed is increaſed, rather than diminiſhed. But if this land is improved, and, after a few crops of corn, ſown out with graſs-ſeeds; and, after being a few years in graſs, brought again into tillage, and ſo on; by this, the whole ſeeds in the land will be brought to vegetate, and the plants deſtroyed before they are ſo old as to carry ſeed.

CHAP. XVI.

Of the methods of deſtroying broom.

AFTER being ſo particular with reſpect to the methods of deſtroying whins, it is not neceſſary to inſiſt much upon the methods of deſtroying broom. For they have a reſemblance to each other, and may be deſtroyed in the ſame manner. It may be obſerved, however, that broom is not ſo buſhy as whins, and does not ſo much cover the ſurface; and, therefore, may more eaſily be deſtroyed by cutting.

IT was obſerved, that, when a field is over-run with whins, it muſt be brought into tillage, after the whins are digged out; otherwiſe they will ſpring up in greater plenty than ever. But it is not ſo neceſſary to uſe a field of broom in this manner. Though the broom is growing thick, yet generally there is a ſward of graſs upon the ſurface. This prevents the ſeeds from ſpringing, when the broom is cut; and, if the broom is old, and cut ſo low as to take away all the leaves, the plants will die. In this manner broom may be deſtroyed, without bringing the land infeſted with it from graſs into tillage *.

THE way in which broom grows, renders it eaſier likewiſe to deſtroy it, than to deſtroy whins, upon land lately turned from tillage into graſs. It was obſerved,

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* A kind of ſcythe has been invented, which performs this work very expeditiouſly.

that ſome perſons propoſe to deſtroy young whins by cutting. If a plant is in its nature hardy, and if it is difficult, in cutting, to deprive it of all its leaves, though it be frequently cut over, yet it will not be eaſily deſtroyed. This is the caſe with the whin: it grows in ſuch a buſhy manner, and puſhes its branches ſo cloſely along the ſurface, that, in cutting, it is not poſſible to deprive it of its whole leaves. But the broom grows differently; it puſhes up one principal ſtem, and the branches from this ſtem are not ſo horizontal as thoſe of the whin. So that, if it is cut near the root, it is deprived of all its leaves: by this it is greatly weakened, and, if frequently repeated, is entirely deſtroyed. When broom is old, one cutting, that deprives it of its leaves, effectually deſtroys it: but it is not certain, that one cutting will as effectually deſtroy young plants; and therefore we have not adventured to aſſert this, though it is natural to expect that it will.

CHAP. XVII.

Of the methods of deſtroying the bramble.

THE bramble is a plant very different from either the whin or the broom. It puſhes its roots very far down, and ſpreads them very wide. The roots may be divided into a number of plants, each of which puts forth ſtems. Though cut down in the winter, it will grow up again in the ſummer, and arrive at ſuch perfection as to carry fruit. It is very difficult to deſtroy it, eſpecially when there are ſtones near the ſurface. For it puſhes down its roots into the ſeams and clefts of the ſtones, from which it is very difficult to tear them. They lodge there, and though frequently cut, yet always ſpring up again. Cutting and tearing up are, however, abſolutely neceſſary to deſtroy them: and, that this may be done in the eaſieſt and beſt manner, the ſtones upon which they grow, ſhould be dug out. The digging out ſtones, and ploughing the land, in ſuch a manner as is moſt proper for cutting and tearing up the roots of the bramble, may be the more ſafely recommended, as by them many other good purpoſes are ſerved.

If the ſtones, in land infeſted with bramble, are allowed to remain, and the land itſelf badly ploughed, and ſeldom fallowed, the bramble will increaſe: but, if the ſtones are carefully digged out, and the land well and clean ploughed, and properly and frequently fallowed, the bramble will decreaſe, few plants will appear, and theſe ſo late in the ſeaſon, as not to come to any height *.

If land infeſted with bramble is lying in graſs, and inconvenient to bring it into tillage, 'tis ſaid, that the bramble may be deſtroyed by ſlitting the end or top of the ſtem. This may be tried at very ſmall

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* There are many places in Eaſt Lothian where, not very many years ago, the bramble was in great plenty; and now, by good ploughing and clearing the land of ſtones, is ſcarcely to be ſeen.

ſmall expenſe, and therefore may be the more ſafely recommended.

CHAP. XVIII.

Of water as an impediment to vegetation.

IT has already been obſerved, that water is a neceſſary ingredient in the food of every plant; that ſome plants require a greater proportion and ſome a leſſer; and that, although ſome of them cannot have too much of it, as it is the element in which they live; yet that others are chilled and deſtroyed by a ſmall quantity *.

IT is proper now to obſerve, that the moſt uſeful plants cultivated in our fields, are of the kind that are deſtroyed by too much water. Such is the nature of our climate, that we have generally more water than is neceſſary. And, if this water is not conveyed away, it not only chills the growing plants, but alſo renders it impoſſible to prepare the land, on which it is allowed to ſtagnate, for the reception of ſeed. Hence water becomes an impediment to vegetation; and it is neceſſary to conſider the moſt proper methods of conveying it away.

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* IT is vain to inquire into the ſecret cauſes of this difference in the natures of plants. Nothing but conjecture can be offered. Beſides, our knowledge of this would ſignify nothing; for that which depends upon the nature of the plant, cannot be altered. Although we knew what it is

CHAP. XIX.

Of the methods of conveying away water.

BEFORE we conſider what methods are moſt proper for conveying away wa-

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is that makes ſome plants require ſo great a proportion of water in their food, and what it is that makes the ſame proportion deſtroy others; yet this knowledge would be of no advantage unto us. For it is more than probable, that we never can, by any kind of culture, ſo far alter the nature of plants, as to nouriſh, by a ſmall proportion of water, thoſe which we find at preſent require a large proportion; or to nouriſh with water only ſuch of them as we find at preſent are effectually deſtroyed by it. Suppoſing ſuch a ſecret is found out, yet it is vain to imagine, that it could be applied to agriculture.

ter, it is neceſſary to inquire, what are the things that occaſion our being troubled with too much of it in our fields? For if the cauſes of the diſeaſe are known, it will be the more eaſy to apply the remedy.

SOMETIMES land is wet from its ſituation; is expoſed to overflowings from higher ground, and has no proper deſcent to allow the water to run off. When a great quantity of rain falls, it ſoon makes its way from the heights into the hollows, and there lodges, till it is exhaled.

SOMETIMES the bottom of land is of ſuch a nature, as to force out, in ſprings, the water that runs below the ſurface. Water runs in channels below ground. Sometimes it ſprings out, becauſe theſe channels, in which it runs, reach the ſurface; and ſometimes, becauſe it meets with an interruption in its courſe, which makes it force its way upward, and break out. When water falls upon land that eaſily admits it, it makes its way downward, till it is reſiſted by a bed of till, clay, or rock. If this bed has a declivity, as is commonly the caſe, the water falls along the declivity. If in any place this bed reaches the ſurface, or if the water meets with any interruption, there it breaks out; or if the ground riſes, and the bed riſes along with it, then the water breaks out in the hollow.

SOMETIMES the wetneſs of land is occaſioned by the ſeaſon, or climate, in which the rain is violent, and ſo frequent, that no time is allowed the land to dry. And

SOMETIMES all theſe things may concur to render land wet. X

x [illegible]

THE wetneſs of land from its ſituation may be prevented. The water, as it falls from the higher ground, may be received into drains, and, by theſe drains, conveyed away; and thus prevented from overflowing the land below. *For although the* land may be ſo low ſituated, as to render it difficult to convey away the water that falls upon it; yet the water may be intercepted, in running from the higher ground, before it reaches the hollow, by a drain, at a place where there may be a ſufficient fall. If the higher ground is in tillage, the ridges and drains of it may be placed in ſuch a manner, as to prevent the water from coming down from it with violence; or the water may be directed, in its courſe, to channels where it can do little harm *.

THE wetneſs of land from the nature of its bottom, may likewiſe, in ſome meaſure, be prevented by drains. Land wet from the breaking out of ſprings, is generally upon a declivity. If the water runs near the ſurface, before it breaks out, it may be intercepted by a drain drawn acroſs the declivity, a little above the place where it firſt makes its appearance. And, if the channel lies deep, it may be prevented from running over the land be-

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* See book 2. chap. 16.

low by a drain, drawn acroſs exactly where it ſprings up. In ſome caſes, it may be known, whether the channel of the water is near the ſurface, or lies deep. If the land is dry immediately above the place where the water ſprings out, it is an evidence that the channel of the water lies deep: if, on the contrary, the land is wet, even at ſome diſtance above the place where the water ſprings out, it is a preſumption, that the channel of the water is near the ſurface. It would be a certain evidence of it, if there were no more ſprings but one. But if there are ſeveral ſprings, ariſing from water running in different channels, the land above the principal ſpring may be wet, not becauſe the channel of the water of this ſpring is near the ſurface, but by the breaking out of other leſſer ſprings, the channels of whoſe waters reach the ſurface, before that of the waters of the larger ſpring.

THE wetneſs of land, ariſing from the climate or ſeaſon, is not to be prevented in the ſame manner, as that which ariſes from the other two cauſes mentioned. When land is wet, either from the overflowings of higher ground, or from ſprings, the water, by drains, may be intercepted; and thus prevented from doing harm. But when the wetneſs ariſes from the climate, or a ſeaſon in which there is too much rain, as is often the caſe, it cannot be made dry by intercepting the water. In this caſe, we can only remove obſtructions, and thereby allow it, as quickly as poſſible, to run away. Caſting drains in places of the field where the water is in danger of ſtagnating, will be of ſome uſe; but this cannot anſwer the end; for thereby no more is done than conveying away the water, that would ſtagnate in the hollow; while nothing is done to convey it from the reſt of the field. And therefore, to drain land in this ſituation, it is neceſſary to lay it up in ridges properly placed, and to cut ſmall drains acroſs the ridges, where neceſſary, communicating with each other, and with the furrows. For, by this method,

thod, all the furrows betwixt the ridges become drains. The water, as it falls upon the ridge, immediately makes its way to the furrows, and along them where there is any deſcent; and, if it is ſtopped in any of them by the ground riſing, is conveyed by the drains acroſs the ridges, into ſome other furrow, where there is a deſcent, along which it makes its way off of the field.

DRAINS have been mentioned, as neceſſary for preventing or removing the wetneſs of land, from whatever cauſe it proceeds. There are two kinds of them uſed: open drains, and hollow drains *. Hollow drains have ſome peculiar advantages. Being covered with earth, no land is loſt, and they are no impediments in ploughing. On theſe accounts, they are

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* HOLLOW drains are made by putting ſtones into open drains, covering the ſtones with turf, bruſh-wood, or ſtraw; and then throwing earth upon the top of all. It is neceſſary that the drains be made in ſuch a manner, that, when the earth is thrown upon the turf, or the other things by which the ſtones are covered, it muſt be of a ſufficient depth to allow a plough to go, without being incommoded.

preferable, in ſome caſes, to open drains. But theſe advantages have made ſome perſons uſe them very improperly, and when they could be of very little uſe. In every caſe, open drains will anſwer the purpoſe of draining; and therefore are always to be uſed, when it is uncertain whether hollow drains will anſwer the purpoſe. Open drains only are proper for intercepting the overflowings of water from higher ground, and for conveying away water that falls in rain. The reaſon why hollow drains will not anſwer theſe purpoſes, is obvious. The water being on the ſurface, cannot find its way to them: if they are on a declivity, the water will run over them, as it does over any other part of the field: and, if they are in a hollow, the water will ſtagnate even above them, and will be moſtly exhaled before any quantity of it reaches them. But hollow drains may be uſed for intercepting the water of ſprings. Becauſe nothing more is required in this caſe, than to continue the channels of the water below ground to a proper place, where its breaking out can do no harm: for which purpoſe hollow drains are very proper.

BEFORE we leave this article, it will not be improper to obſerve, that land is ſometimes wet from the nature of the ſoil.

THERE are two kinds of ſoil, that are much expoſed to be damaged by water. The ſoil in which there is a great mixture of clay; and the ſoil in which there is a great mixture of moſs. Experience ſhows, that both theſe kinds of ſoil take much longer time to dry than others, that have received as much water, and are in the ſame ſituation.

WE will beſt know how to render theſe ſoils dry, by inquiring into the cauſe of their wetneſs.

IT is obſerved, that clay is a heavy body; that it does not eaſily receive water, but that it retains a large quantity, and will not eaſily part with it, when once received.

received. It would ſeem, then, that clay has many pores, but that its pores are ſmall. Having many pores, it is capable of containing a large quantity of water; but, its pores being ſmall, the water does not eaſily enter into it, or paſs through it.

It is obſerved, that moſs has ſtill worſe qualities than clay; for it not only retains a large quantity of water, but alſo eaſily admits it. It would ſeem, then, that its pores are large; but that it has a ſtrong abſorbent quality, or contains a great quantity of undiſſolved oil. The largeneſs of its pores eaſily admits water, and its abſorbent quality, or the undiſſolved oil, which it contains, prevents the paſſage of the water through it.

It is obvious, that laying up ſuch lands in ridges, and caſting drains in proper places, though of ſome uſe, yet will not effectually remove the water; as the ſoil, from its nature, retains too large a quantity, and will not give it a paſſage into the furrows or drains, though there is a ſufficient deſcent. To drain ſuch land, it is neceſſary therefore, by culture, to change the nature of it, and, in ſome meaſure, deſtroy its power of retaining water.

As the pores of clay are ſo ſmall, that water cannot find an eaſy paſſage through it; to drain this kind of ſoil, its pores muſt be enlarged. The methods propoſed, in chap. 6. of this book, for enlarging the paſture of plants, ſeem to be very proper for this: frequent ſtirring, and the application of ſuch manures as raiſe a fermentation. Theſe operations open the pores, render the ſoil free and open, and thereby the water finds a more eaſy paſſage through it. The manures particularly, that are long in diſſolving, are the moſt proper; for, till they are wholly diſſolved, they keep the ſoil continually open.

Some perſons have obſerved, that clay has this bad quality; though reduced to powder, yet, when mixed with water, becomes as ſolid again as ever. As this is the caſe, though manures may help to make it part with the water, as they open the ſoil by fermentation, both in the time of the rain and after it has fallen, yet frequent ploughings can do but little ſervice; on the contrary, by opening the ſoil, make it receive the water more eaſily. It is therefore recommended to all perſons, who have this kind of ſoil to deal with, as a matter of the greateſt importance, to lay up the land, before the rainy ſeaſon comes on, in ſuch a manner, as allows the water the moſt eaſy paſſage, and expoſes it beſt to the influence of the winds. For thereby a great quantity will run off, and be exhaled, which otherwiſe would ſink into the land.

As moſs has its pores too large, and has an abſorbent quality, or a large quantity of undiſſolved oils, which prevents the paſſage of the water through it; to drain this kind of ſoil, it is neceſſary to leſſen its pores, render it more compact and firm, and, if poſſible, deſtroy its quality of retaining water. Frequent ſtirring, as already mentioned in the caſe of clay, and the application of ſuch manures as raiſe a fermentation, will leſſen its pores, and render it more firm and ſolid; and thereby prevent it from receiving ſo large a quantity of water. And the application of ſuch manures, as tend to make the moſs putrefy, and to diſſolve its oils, will, in ſome meaſure, deſtroy its power of retaining water, and thereby allow it a more eaſy paſſage.

SOMETIMES it is obſerved that land is wet, though there is in it a great mixture of ſand or gravel. Theſe are kinds of ſoil which allow the water an eaſy paſſage, and are commonly very dry. When they are wet, this muſt be owing to the nature of the bottom. Clay, till, or ſomething that does not eaſily admit water, muſt lie near the ſurface. When this is the caſe, the land, though on a declivity, will be wet after violent rain. The water is eaſily admitted by the ſand or gravel on the ſurface; it is reſiſted by the clay, or till, in the bottom; and, though it deſcends along theſe, yet the abſorbent quality of the ſoil, and the other interruptions which the water meets with, render its motion very ſlow. When land in this ſituation is on a plain, the qualities of the ſand and gravel can be of little uſe to render it dry. It is needleſs to propoſe drains in either of theſe caſes. The method of ploughing is the only thing that can be of ſervice. Forming the ridges in ſuch a manner as to make many furrows, and placing them in ſuch a manner, as to make the furrows intercept the water, ſeems to be the proper way of draining this kind of land, when on a declivity; and the forming the ridges in ſuch a manner, as beſt to expoſe the ſoil to the influence of the air and winds, ſeems to be the proper way of draining it, when on a plain *.

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* See book 2. chap. 14. and 16.

CHAP.

CHAP. XX.

Of the methods of draining mariſhes.

THERE are many mariſhes in Scotland. Some have been drained, and turned into very fertile land. The water which ſupplies theſe mariſhes ariſes from ſprings, which are obſerved commonly in great plenty at the bottom. The water of the mariſhes having no current, allows plants to grow from time to time. Theſe plants, with the earth waſhed down from the high grounds, by which mariſhes are commonly ſurrounded, and the duſt blown in by the winds, have by degrees formed a ſpungy ſoil, which may be ſaid to float on the water. A ſoil, formed in this manner, muſt be rich; and, when drained, of great value.

To drain a mariſh, it is neceſſary, in the firſt place, to convey away all the ſtagnating water; and this water can be conveyed away in no other manner, than by a large open drain, with a ſufficient fall. This fall muſt be ſuch, as to carry off the water from the bottom of the mariſh; otherwiſe little advantage is to be expected from it. By conveying away all the ſtagnating water, ſome land on each ſide will be gained: for, the water being removed, the earth, by degrees, will ſubſide, and become firm and ſolid. By this likewiſe the bottom will become firm; which will allow the drain, by degrees, to be carried forward through the middle of the mariſh. If the ſprings, by which the mariſh is ſupplied, ariſe near the middle; this principal drain, with ſome branches out from it on each ſide, where the ſprings are largeſt or moſt numerous, will be ſufficient. But if there are ſprings in all places, as is frequently the caſe, it will be neceſſary to make drains at the ſides, as nearly parallel to the principal drain, as the ſituation of the mariſh will allow, to intercept the water that comes from the heights, and ſupplies the ſprings. It will be neceſſary likewiſe, to make communications, by croſs drains, betwixt the parallel drains at the ſides, and the principal drain in the middle. All theſe drains muſt be kept open for ſome time. When the earth hath fully ſubſided, and become firm and ſolid, then the drains upon the ſides, and the croſs drains, may be turned from open into hollow drains: though it would be more proper, if the mariſh is large, to turn ſome of them into fences for incloſures. The principal drain, if the mariſh is large, ſhould always be kept open; and, though ſmall, ſhould not be altered, except the earth becomes quite firm, and there is a deſcent for conveying away the water as it falls.

B O O K II.

Of TILLAGE.

C H A P. I.

Of the deſign.

IT was obſerved in the laſt book, that ſtirring and turning over the earth is proper for increaſing the food of plants, enlarging their paſture, and deſtroying weeds. It was obſerved likewiſe, that laying land in ridges, is neceſſary, in many caſes, to drain it when wet. This operation, by which the earth is ſtirred and turned over, and by which land is laid up in ridges, is called *tillage*.

THAT this operation of tillage may be performed in ſuch a manner as to anſwer the ends propoſed, it is of importance to know theſe things following: The natures of the different ſoils proper for producing plants; the inſtruments proper for ſtirring and turning over theſe ſoils; and the manner of conſtructing and uſing theſe inſtruments. By the knowledge of theſe things, tillage will be performed in ſuch a manner as better to anſwer the end propoſed, whatever it is; whether the increaſing the food of plants, enlarging their paſture, deſtroying weeds, or removing wetneſs. To inquire, then, into theſe things, is the deſign of this book.

C H A P. II.

Of the diviſion of ſoils with reſpect to tillage.

IT is difficult to reduce the different ſoils to proper claſſes. Every ſoil is a compoſition of different kinds of earth, and is diſtinguiſhed by the kind that prevails moſt; ſuch as clay, moſs, ſand, *&c.* When treating of ſoils with reſpect to tillage, it is needleſs to diſtinguiſh them in this manner. It is more proper to divide them into theſe kinds following: ſtiff and light, wet and dry, deep and ſhallow. The reaſon of this is obvious: the method of performing this operation of tillage, has a reference to one or more of theſe qualities of ſoil, and to no other. When treating of ſoils, with reſpect to the application of manures, another diviſion may be neceſſary, and other qualities conſidered. But, in treating of tillage, this diviſion is ſufficient. It is proper, however, to obſerve, that there are different degrees of all theſe kinds of ſoil; which makes a great variety of them, and as great a variety in the methods of management.

CHAP. III.

Of the inſtruments uſed in tillage.

THERE are a variety of inſtruments uſed in tillage: the plough, the harrow, the roller, the hoe, the ſpade, *&c.* There are a variety of kinds alſo of theſe different inſtruments. The firſt three of them are the inſtruments chiefly uſed in our fields: the plough, the harrow, and the roller. We ſhall confine ourſelves therefore to the conſideration of them; and we begin with the plough, as the moſt important.

CHAP. IV.

Of the plough.

THE plough is the principal inſtrument uſed in tillage. There are ſeveral different kinds of ploughs uſed in Scotland: the old Scots plough, the plough with the carved mold-board, the plough with the feathered ſoke, the wheel-plough, the four-coultered plough, and the iron plough. All of theſe ploughs differ from each other. The difference betwixt ſome of them and others is very conſiderable.

EACH kind has its admirers, and, no doubt, its peculiar properties. It will not be amiſs, that we give all of them a particular examination, conſider the ſeveral parts of each, ſhow the various uſes of their ſeveral parts, and compare the ploughs themſelves, and their operations, with one another. By this we will beſt know, in what reſpects one kind is preferable to another; and likewiſe how, and on what occaſions, the different kinds are to be uſed.

The author of the new ſyſtem of agriculture takes upon him to ſay, that there are no leſs than an hundred different ploughs in England, and all of them bad. He likewiſe aſſerts, that two kinds only are neceſſary. He deſcribes the two kinds; and calls the one a ſtrong plough, and the other a ſmall. The ſtrong one, he ſays, is for hard ſtiff clay; and the ſmall one for ſoft mellow land These ploughs, he does not pretend, are fitter for tillage than the others; but that they are much eaſier drawn. Two oxen are ſufficient, he ſays, for the ſtrong one; and two horſes, or even one, for the other. He aſſerts, that one of theſe ploughs, with two cattle, will do more work than one of the common ploughs with ſix. Such aſſertions are but too common with the writers on agriculture; and are evidences of nothing ſo much, as of the aſſurance, the pride, and partiality of mankind.

CHAP. V.

Of the old Scots plough.

IT is proper to begin with this plough, as it is as yet the moſt common. It is ſuppoſed to be the plough moſt generally underſtood; and therefore the other ploughs ſhall be compared with it, rather than with one another. When right made, it is the beſt general plough; that is, the moſt proper plough for all purpoſes, when one only is uſed. Some of the other kinds of ploughs are, perhaps, more proper for ſome particular uſes; but none of them are ſo fit for all purpoſes. This may appear ſurpriſing to ſome perſons; and, therefore, it is neceſſary to obſerve, that, by the plough, we mean the original ſtructure, form, or plan of the plough, and not this plan ill executed, as it is in many of the ploughs in the different parts of the country. Becauſe bad tradeſmen make this plough heavy and clumſy, ſome perſons ſeem to imagine, that this is entirely owing to the kind of plough: but this is unreaſonable; for it is certain, that this plough may be made as light and neat, as any kind of plough whatever.

WHEN we aſſert, that the Scots plough is the moſt proper for all purpoſes, it muſt be remembered, that we have in view the lands of Scotland, in their preſent ſituation. In lands that are improved, where the faſt ſtones have been carefully digged out, and the ſmaller ſtones frequently gathered off *, and the land kept free of the roots of quickening-graſs; the Scots plough may be made ſmaller and lighter, than in the following deſcription; ſome improvements may be made upon it, and even ſome other kinds uſed to greater advantage. But, while our

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* In a ſcheme of management which requires the frequent laying off land into graſs, for hay; the ſmaller ſtones will be all gathered off in a ſhort time.

lands are in their preſent ſituation, this plough will be found, upon trial, to be the moſt convenient.

THE ſeveral parts of this plough are; the head, the beam, the ſheath, the wreſt, the mold-board, the two handles, and the two rungs; theſe are of timber: and there are of iron, the ſoke, and coulter. Theſe different parts are deſigned for the purpoſes following; the head and ſoke for opening the land below; the coulter for cutting any thing that is hard, on the ſurface, and for ſeparating from the firm land the earth that is ſtirred and turned over by the plough; the wriſt and mold-board for raiſing this earth, and turning it over; the beam for fixing the draught to, and keeping the ſeveral parts of the plough together; the two handles for directing and managing the plough; and the two rungs for fixing the two handles together.

THOUGH the original form and ſtructure of this plough is good, and though a great deal depends upon the juſt proportions of its ſeveral parts; yet few perſons have examined it with that accuracy which it deſerves. Some, taking it for granted that the original form of it is bad, have endeavoured to introduce ploughs of a different form in its place; and, without knowing whether or not the ſeveral parts of it are in their juſt proportions and poſitions, have been prevailed upon to atteſt, That, upon trial, a plough of another form is found to be more eaſily drawn, and to make better work. A comparative trial is, no doubt, the proper way to judge which of two ploughs is the beſt: but, by this trial, we cannot determine which of two kinds is the beſt, unleſs we know, that both the ploughs tried are equally good of their kind. This is mentioned to prevent perſons from being impoſed upon by pretended trials, and to engage them to make themſelves maſters of the ſtructures of the different ploughs, before they determine which is the beſt.

BUT though it ſhould be allowed, that, in ſome reſpects, the Scots plough is inferior to ſome others lately introduced; yet ſtill it may be uſeful, particularly to thoſe who are attached to it, to give a particular deſcription of it, and to ſhow how to make it, in the manner moſt proper to anſwer the purpoſes deſigned.

THAT this deſcription of the Scots plough may be the better underſtood, we ſhall conſider the ſeveral parts of it ſeparately, and ſhow how they are joined together; and, to aſſiſt us, ſhall make uſe of a few figures.

THE part of the plough that falls naturally to be conſidered, in the firſt place, is the head *; ſee fig. 1. The length of the head, from A to B, is about twenty inches; and the breadth, from A to D, about five inches. C is the point upon which the ſoke is driven; and the length

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* THIS part of the plough, which, in Scotland, is called the *head*, is commonly, in England, made of iron, is of one piece with the ſoke, and is called the *plough-ſhare*.

from B to C, is about ſix inches. a is the mortoiſe, into which the larger handle is fixed; and b is the mortoiſe, into which the ſheath is fixed.

THE head is the part of the plough that goes in the ground. The ſhorter therefore that it is, the friction is the leſs, and the plough the eaſier drawn; and the longer that it is, the plough is the more ſteady in going, and not ſo eaſily put out of its direction, when it meets with obſtructions. Twenty inches may be conſidered as a mean length, and will anſwer tolerably well in every ſort of land. In land where there are few obſtructions, it may be a little ſhorter; but in land where there are many obſtructions, it ſhould be a little longer. The narrower that it is, provided it is ſtrong enough, the better; for the friction is the leſs, and the breadth ſerves no purpoſe, but to make it ſtrong. The two mortoiſes in it will not allow it, at leaſt where they are, to be much leſs than five inches, even in land where the plough meets with the feweſt interruptions in going. The length from B to C is for fixing the ſoke, and whatever ſerves this purpoſe is ſufficient.

THE ſheath falls naturally to be conſidered in the next place. It is repreſented, in fig. 2. by E B. It is driven into the mortoiſe, b; and thus fixed to the head A B. It is not perpendicular to the head, A B; but placed obliquely, ſo as to make the angle, contained by the lines E B and A B, about 60°. It is about thirteen inches long, beſides what is driven into the mortoiſe, b; about three inches broad, and one thick *.

Now it is to be obſerved, that to the ſheath is fixed the mold-board, as in fig. 10. in the ſame manner as the wriſt is fixed to the head in fig. 7. The deſign of the mold-board is to turn over the earth

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* THIS part of the Scots plough, which we call the *ſheath*, has the ſame name given it by ſome of the Engliſh writers. But, in the new-modelled Hartfordſhire wheel-plough, that which anſwers to the ſheath is called the *fore-ſheat*.

of the furrow, which the plough makes: and it is obvious, that, according to the poſition of the ſheath, the earth of the furrow is turned over more ſuddenly, or is raiſed and turned over more gradually. If the ſheath is ſet near the perpendicular, the earth of the furrow, in riſing up from the fore part of the wriſt, is ſoon reſiſted by the mold-board, and turned over ſuddenly. For, if the ſheath, inſtead of being placed in the poſition E B, is placed nearer the perpendicular, in the poſition e B, the mold-board, as it makes an angle with the plane of the head and ſheath, of about 30°, as ſhall be ſhewn afterwards, will be raiſed above that plane, at the point f, and will give reſiſtence to the earth of the furrow, at a place of the plough, where no reſiſtance is given, if the ſheath is in the poſition E B; and therefore will turn it over more ſuddenly. On the other hand, if the ſheath, inſtead of being placed in the poſition E B, is placed more ſloping in the poſition g B, then the earth of the furrow is higher raiſed up, before it meets with the ſame reſiſtance; as when the ſheath is in the poſition E B, and is turned over more gradually.

It may be obſerved likewiſe, that, according to the poſition of the ſheath, the upper part of it, where it is fixed to the beam, is nearer, or at a greater diſtance from the coulter: ſee fig. 6. And, according to this diſtance, the plough is in greater or leſs danger of being choked (as the ploughmen term it), when going in land that is full of the roots of quickening-graſs, or has upon it a rank ſtubble. Any perſon that will carefully obſerve a plough going in land in either of theſe ſituations, will ſoon find, that the ſtubble, or the roots, which the plough puſhes before it, are ſometimes intangled betwixt the coulter and ſheath, and thereby the plough interrupted. The nearer that the ſheath and coulter are to each other, where they are fixed to the beam, this happens the oftener; and, the farther they are from each other, this happens the ſeldomer.

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IF the ſheath ſlopes in ſuch a manner, as to make an angle with the head of about 60°, the earth of the furrow will be ſufficiently raiſed up, before it is turned over; and the ſheath and coulter will be at a ſufficient diſtance from each other, where fixed to the beam.

THE length of the ſheath depends upon the poſition of the beam. As the beam is high or low ſet, the ſheath muſt be longer or ſhorter. It is commonly about a foot from the upper ſide of the head to the under ſide of the beam. It is needleſs to give directions about the breadth and thickneſs, for they ſerve no purpoſe but to render it ſtrong.

THE larger handle falls to be next conſidered. It is repreſented in fig. 3. by F A. It is fixed to the head, by driving it into the mortoiſe, a. It is in length, from A to F, about five feet four inches; and in diameter, at A, and upwards to the place where it is fixed to the beam, about two and an half inches; but it becomes leſs and leſs, as it approaches to F. The handle is not ſtraight; about ten inches from A, there is a curve, which, when F is raiſed to its proper height, makes the lower part of it nearly parallel to the ſheath E B. To determine the poſition of the handle, extend the line B A, and raiſe the end of the handle, F, ſo that the perpendicular F G, let fall from F upon B A, extended to G, may be about three feet two inches; that is, that it may be about three feet two inches from the end of the handle, which the ploughman holds by, to the bottom of the furrow which the plough makes when going.

According to the length of the handles, the perſon that holds the plough manages it the eaſier. The reaſon is obvious; the longer that the handles are, the ends of them, which the ploughman holds by, are the farther removed from the centre of gravity; and therefore the plough itſelf is turned by them with leſs ſtrength. If the larger handle is about five and an half feet, the plough may be eaſily managed upon any kind of land. The handles of the Hartfordſhire wheel-plough are ſhorter; but then it is to be obſerved, that the wheels regulate the plough, and leave the perſon that holds very little to do.

The higher that the ends of the handles are raiſed, provided they are no higher than the lower part of a man's breaſt, the perſon that holds can the more eaſily raiſe the plough out of the ground. For the plough is raiſed out of the ground by preſſing upon the handles, which raiſes the fore part of the plough: and a perſon can preſs with greater force when ſtanding upright, than he can do when obliged to ſtoop. On the contrary, the lower that the handles are ſet, the ploughman can the more eaſily force the plough into the ground. For the plough is forced into the ground by raiſing the handles, which ſinks the fore part of the plough; and a perſon can raiſe a weight much more eaſily, when he is obliged to ſtoop to it, than when it is raiſed above his hand. When the handles are ſet about three feet high, a perſon of an ordinary ſize may manage the plough; and, with no great difficulty, can either raiſe the plough out of the ground, or force it into it.

THE deſign of the curve in the handle is to ſtrengthen the plough. For the nearer that the lower part of it, by the curve, approaches to the parallel of the ſheath, the beam is the ſhorter, and the plough more compact and firm.

WE proceed next to the deſcription of the beam It is repreſented in fig. 4. fixed to the larger handle and the ſheath; all of which, with the head, are in the ſame plane. X The length of it, from H to I, is about ſix feet. [illegible] inches diameter; and it [illegible] a manner, as to make the perpendicular *c d* about five inches.

THE plane of the beam [illegible] raiſed above the plane [illegible] when the plough [illegible]

Vid. Addit.s, p. 11.

depth, the beam may not be incommoded by any thing on the ſurface. × But it ought to be no higher raiſed than is neceſſary; for the nearer it is to the head, the ſheath is the ſhorter, and the plough more compact and firm. Let the head, B A, be extended to K, and let the perpendicular, K H, be raiſed upon B A extended, ſo that it may be about ten inches, from K to the place where the perpendicular cuts the handle, at H; and H is the proper place to which the end of the beam is to be fixed. This makes it ten inches, from that place of the handle to which the beam is fixed, to the bottom of the furrow made by the plough in going.

THE poſition of the beam depends upon the number of cattle in the plough, and the manner in which they are yoked: and it is ſet high or low, according to the direction of the draught.

To determine the poſition of the beam, when there are two horſes in the plough yoked abreaſt, extend A B, the other way, to L, ſo that the diſtance from K to L may be thirteen feet; which is allowing ſix feet for the length of the beam, and ſeven feet for the diſtance of the ſhoulders of the horſes, from the point of the beam. At L, raiſe the perpendicular L M about three feet four inches, being the height of that part of the ſhoulders of the horſes, to which the draught is fixed. Then determine, as exactly as poſſible, what point in the line A B is the centre of gravity of the plough; which, when the plough is finiſhed, will be found to be near to B. Join M to B, and bring the end of the beam, I, to touch the line B M; and this is the proper poſition of the beam, when there are only two horſes in the plough yoked abreaſt.

When the beam is placed in this manner, let fall the perpendicular, I N, from the place to which the draught is fixed, upon A B extended. This perpendicular is found to be about fifteen inches: ſo that, if a rule is laid along the head, and extended forward, and the beam placed in ſuch a manner, as to make the neareſt diſtance from the bolt-hole, at the end of the beam, to the rule, about fifteen inches; it is right placed, as before directed, when two horſes only are in the plough, yoked abreaſt.

To determine the poſition of the beam, when there are four horſes in the plough, yoked two abreaſt, extend A B to O, ſo that K O may be twenty-two feet, which is allowing nine feet for the diſtance of the ſhoulders of the firſt pair from the ſhoulders of the laſt pair; at O raiſe the perpendicular O P equal to L M, and join P to B. Two equal forces are now applied to the plough in different directions; the one in the direction B M, and the other in the direction B P. Biſect the angle M B P by the line B Q, and B Q is the direction of the two forces united. Bring the end of the beam to touch the line B Q, and this is the proper poſition of the beam when four horſes are in the plough yoked two abreaſt. Let us ſuppoſe that the end of the beam cuts the line B Q at Q, then the beam is in the poſition H Q, and the perpendicular Q N is found to be about twelve inches; ſo that if the beam is placed in ſuch a manner, that the neareſt diſtance from the bolt-hole to the rule, in the poſition formerly mentioned, is about twelve inches, it is right placed, when there are four horſes in the plough yoked two abreaſt. In the ſame manner may be found the true poſition of the beam, whatever number of cattle there are in the plough, or in whatever manner yoked *.

The beam is made ſix feet long. It is

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* Though a plough is right conſtructed, yet in ſome lands it will go too deep, and in others not deep enough; this is owing to the oblique poſition of the coulter meeting with reſiſtance on different places. If the land is ſoft and free above, and hard below, as is the caſe when one is inclined to plough a field a little deeper than uſual, the reſiſtance which the point of the coulter receives, gives the plough a tendency to come out of the ground; and when the land is firmer above than below, as is the caſe when there is a tough ſward of graſs upon ſoft land, then the reſiſtance which the coulter meets with above, more than below, makes the plough go in too deep. It is very difficult to make a plough go in land of this kind at an equal depth, without having a wheel at the end of the beam.

obvious that it cannot be much ſhorter. The draught in a four-horſe plough muſt be fixed in the line B Q. Now, ſuppoſing that the beam is ſix feet, Q N is only twelve inches; that is, twelve inches from the bolt-hole to which the draught is fixed, to the bottom of the furrow made by the plough in going. Suppoſing likewiſe that the plough makes a furrow eight inches deep, as is ſometimes done, then there are only four inches from the bolt-hole to the ſurface, and if the beam is but three inches diameter at the bolt-hole, which is the leaſt that can be ſuppoſed, there are only two inches and an half from the under ſide of the beam to the ſurface, which is as little as can be allowed, to prevent the beam from meeting with interruptions in moving forward. But if the beam is made leſs than ſix feet, to bring the bolt-hole to the line B Q, it muſt be ſet lower; and if this is done, the beam has not freedom to move, if the furrow is eight inches deep. The beam, however, may be made ſhorter in a two-horſe plough, or an ox-plough. The draught in theſe ploughs muſt be fixed in the line B I, and the bolt-hole may be brought to R, which makes the beam ſix or ſeven inches ſhorter, and yet ſtill as far from the bottom of the furrow as in a four-horſe plough when it is at Q. The length of the beam, however, depends upon the depth of the furrow intended. If the furrow, at any time, is to be more than eight inches deep, the beam muſt be more than ſix feet long; but if it is never to be ſo much as eight inches deep, the beam may be leſs than ſix feet.

The beam is curved ſo as to make the perpendicular *c d* about five inches; *e* is the place of the beam through which the coulter paſſes, and it ſlopes in the poſition *e f*. When there is any ſtubble or a ſward of graſs on the ſurface, or any roots in the land, they are raiſed up by the plough in going; and if immediately before the coulter the beam is placed near the ſurface, the things raiſed up by the plough are intangled betwixt the coulter and beam, and thereby the plough is much incommoded.

The more that the beam is curved, that is, the longer that the perpendicular *c d* is, the plough is the leſs incommoded; for the things raiſed up by the coulter, not being ſo ſoon reſiſted by the beam, are turned to a ſide along with the earth of the furrow, inſtead of being intangled betwixt the beam and the coulter. But the longer that *c d* is, the beam is the more eaſily broke, and the ſheath and coulter being longer, are thereby rendered weaker, and the more eaſily broken likewiſe. When the beam is curved in ſuch a manner as to make *c d* about five inches, the impediments that the plough meets with in going may eaſily be removed, or, according to the language of the ploughman, the beam is well redd, and at the ſame time ſufficiently ſtrong.

THE perpendicular H K let fall from the place where the beam is fixed to the larger handle, to the plane of the head continued to K, is ten inches, according as the beam is curved, the end of it at H muſt be ſet higher or lower. If it is much curved, it may be ſet the lower, becauſe the curve raiſes from the ſurface that part of the beam by which the plough is incommoded; but if little curved, it muſt be ſet the higher, that ſo before the coulter it may be raiſed to a proper diſtance from the ſurface. When the perpendicular *c d* is about five inches, the perpendicular H K may be about ten inches.

The poſition of the beam depends upon the way of yoking the cattle, and the direction of the line in which they draw. If the perpendiculars M L and P O are made longer, or brought nearer the plough, then the end of the beam at I or Q muſt be higher raiſed; and if the perpendiculars are ſhorter, then the end of the beam muſt be lower ſet. When K L is thirteen feet, and L M three feet four inches, ſo that the draught is in the direction B M, then I N is fifteen inches; but if K L is leſs than thirteen feet, or L M more than three feet four inches, I N muſt be more than fifteen inches; or if K L is more than thirteen feet, or L M leſs than three feet four inches, I N muſt be leſs than fifteen inches. In like manner, if K O is twenty-two feet, and O P three feet four inches, and two draughts given to the plough, the one in the direction B M, and the other in the direction B P, ſo as to make the direction of the united draughts in the line B Q, then I coincides with Q, and I N is only twelve inches: but if K O is leſs than twenty-two feet, or O P more than three feet four inches, I N muſt be more than twelve inches; or if K O is more than twenty-two feet, or O P leſs than three feet four inches, I N muſt be leſs than twelve inches *.

FIG. 5. repreſents the ſoke fixed to the end of the head; it is about two feet long. As the head is twenty inches, the parts of

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* FROM the account here given of the method of placing the beam, it will appear how the plough may be made to go deeper or ſhallower, by the ways of yoking the cattle. By placing the cattle at a greater diſtance from the plough, or putting the traces lower upon their ſhoulders, the plough is made to go deeper; and by bringing the cattle nearer the plough, or raiſing the traces, or ſhortening the back ropes, the plough is made to go ſhallower.

the Scots plough that anſwer to the Engliſh ploughſhare, are in length about three feet eight inches.

IN fitting the ſoke to the head, it is found neceſſary to turn the point of it a little towards the land, or to the left ſide. The reaſon is this: The ſoke, in going forward, meets with greater reſiſtance from the land-ſide, which is firm, than it does from the furrow-ſide, which eaſily yields to it. This gives the plough a tendency to come out of the land; and therefore, to prevent this, it is neceſſary to turn the point of the ſoke a little towards the land. By turning the point of the ſoke, an alteration is made in the going of the plough. When turned to the left ſide, as has been obſerved, the plough takes off more land; when turned to the right, it takes off leſs land; when turned upwards, the plough goes ſhallower; and when turned downwards, it goes deeper: for to the ſide to which the point of the ſoke is turned, the plough naturally tends, from the reſiſtance it meets with from the oppoſite ſide.

But it is obvious, that the turning the point of the ſoke, not only makes an alteration in the going of the plough, but alſo makes it not ſo eaſily drawn. For let us ſuppoſe, that the ſoke, inſtead of being in the direction B P, is in the direction B O; ſee fig. 5. The beam and the head being in the ſame direction, the plough muſt move forward in the direction A B; and it is obvious, as this is the caſe, that it meets with greater reſiſtance, when the ſoke is in the direction B O than when in the direction B P. When the ſoke is in the direction B P, the point opens the furrow to its full depth, and no reſiſtance is given but to the upper ſide, by the raiſing of the earth; but when it is in the direction B O, reſiſtance is not only given to the upper ſide, by its raiſing the earth, but a much greater reſiſtance is given to the under ſide by its opening the furrow. For as B is much lower than O, the furrow is not opened to its full depth by the point of the ſoke, but is made deeper and deeper by the under ſide of it, as it moves forward; which is a great interruption to the plough, and makes it much heavier to draw.

It may be obſerved likewiſe, that the going of the plough depends, in ſome meaſure, upon the length of the ſoke. The longer that the ſoke is, the plough goes the deeper; and the ſhorter that it is, the plough goes the ſhallower. The reaſon is this: When the ſoke is made long, the centre of gravity is brought forward from B. × This would require the end of the beam to be ſet lower; and, if this is not done, the plough muſt go too deep. On the other hand, if the ſoke is ſhort, the centre of gravity is put back from B, which would require the beam to be a little raiſed; and, if this is not done, the plough muſt go too ſhallow. That a change of the centre of gravity requires an alteration in the poſition of the beam, is certai[illegible]r, le[illegible]poſe that the cent[illegible]ity[illegible]of being at B, i[illegible]B to M[illegible]nd *a* [illegible]gth[illegible]am [illegible]ne fo[illegible]de[illegible]ribe

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ſcribe the arc N I Q. When the centre of gravity is at B, the end of the beam muſt be at I; for it is there that it touches the line B M. But if the centre of gravity is at *a*, the end of the beam muſt be at Q; for it is there that it touches the line *a* M; and thus, when the centre of gravity is brought forward, the beam muſt be lower ſet. Let us now ſuppoſe, that the centre of gravity is, on the other ſide of B, at *b*; join *b* to M. The point of the beam muſt now be at N; for it is there that it touches the line *a* M: and thus, when the centre of gravity is put back, the beam muſt be raiſed.

Fig. 6. repreſents the coulter fixed to the beam. It is about two feet ten inches long, two and an half inches broad, ſharp at the point, ſharp alſo before, and thick on the back, like a knife. To determine the place of the coulter, raiſe a perpendicular at B, upon the head A B; and where that perpendicular cuts the beam, is the place through which the coulter paſſes. It is fixed and directed by wedges, ſo as to place the point of it equal to, or rather a little before the point of the ſoke; and upon a line with the left ſide of the head. This oblique poſition of the coulter makes it have the greater influence. For when it meets with roots, or any other things that interrupt its going, it throws them out of the land, which requires leſs ſtrength, than cutting or puſhing them forward; which it muſt do, if ſet near the perpendicular. Beſides, in this oblique poſition, it more eaſily cuts any thing that is hard, as it moves forward, than when placed more upright. Its other poſition, with the point in a line with the left ſide of the head, makes it open the furrow in ſuch a manner, as to prevent the reſiſtance to the head from being ſo great as it would be, if the point of the coulter was placed more to the right. For, if the point of the coulter is placed to the right of this line, the left ſide of the ſoke rubs upon the firm land; but, if the point of the coulter is placed exactly in this line, then this ſide of the ſoke meets with no reſiſtance, but from the earth that falls betwixt the ſoke and the coulter. On the other hand, if it is placed to the left of this line, it will force a great load of earth upon the ſoke, meet with more reſiſtance itſelf, and be in greater danger of being broken, or put out of its direction. From this we may obſerve, that the going of the plough depends, in ſome meaſure, upon the poſition of the coulter. If the coulter is placed upon a line with the left ſide of the head, then the plough meets with little reſiſtance on that ſide, and goes ſtraight forward: but, if the coulter is placed to the right of this line, then the plough meets with reſiſtance on that ſide, and is forced out of the land. And, if it is placed to the left of this line, the reſiſtance which it meets with on the right ſide, forces the plough a little towards the land. The placing the coulter in this way, with the point of it much towards the land, has another effect; it makes the plough go more ſteadily. The greater that the diſtance is betwixt the point of the coulter and the point of the ſoke, the earth that the coulter goes in, is the firmer; and thereby it becomes the more difficult for any interruption which the ſoke meets with, to put the plough out of its direction. A lazy ploughman, ſenſible of this, for his own eaſe, will make this diſtance much greater than it ought to be, if care is not taken to prevent him. But the going of the plough depends not only upon the poſition of the point of the coulter, but alſo upon the poſition of the plane of it. If the coulter is placed in ſuch a manner, that the plane of it cuts the plane of the head behind, or has the fore part of it turned a little to the left; then the reſiſtance which the coulter meets with, makes the plough tend to the left. On the other hand, if the coulter is placed in ſuch a manner, that the plane of it cuts the plane of the head before, then the reſiſtance which the coulter meets with, makes the plough tend to the right.

FIG. 7. repreſents the wriſt fixed to the head. B K is the wriſt: it is about twenty-ſix inches long, two inches broad, and one thick. The wriſt, B K, is fixed to the head A B, at B, in ſuch a manner, as to make the angle contained by the lines A B and B K, about 30 degrees. The wriſt is ſeldom, or rather never, placed in the ſame plane with the head; but raiſed gradually from the place where it is fixed to it; that is, from B to K, as in fig. 8. The poſition of the wriſt determines the kind of furrow that the plough makes. In proportion to the greatneſs of the angle A B K, in fig. 7. and to the ſmallneſs of the angle A B K, in fig. 8. the furrow that the plough makes in going is wide below. And, in proportion to the ſmallneſs of the angle A B K, in fig. 7. and the greatneſs of the angle A B K, in fig. 8. the furrow that the plough makes is narrow below; that is, as the wriſt is wide and low ſet, the furrow is wide; and, as the wriſt is narrow and high ſet, the furrow is narrow.

Fig. 9. repreſents the two handles fixed together by the two rungs. The larger one has already been deſcribed; the leſſer one is a few inches ſhorter, and need not be made quite ſo ſtrong. The diſtance of the two handles, at the little rung, depends upon the poſition of the wriſt. Their diſtance, at the ends F and N, is about two feet ſix inches. Now, it is to be obſerved, when the larger handle, A F, is fixed into the mortoiſe, *a*, of the head A B, and the leſſer handle, L N, to the wriſt K B, at L; ſee fig. 7.; that the handles not only riſe gradually from A and L, till, at F and N, they are about three feet two inches high; but alſo gradually increaſe in diſtance, till, at the ſame places, their diſtance is about two feet ſix inches.

Fig. 10. repreſents the leſſer handle fixed to the wriſt and mold-board, and the mold-board fixed to the ſheath. E B is the ſheath, B K the wriſt, L M N the leſſer handle, and B E M K the mold-board. Now, as the ſheath, the head, the beam, and the larger handle, are all in the ſame plane; and as the handles gradually recede from each other, as they proceed upwards, it follows, that the upper part of the mold-board, at M, is at a greater diſtance from the plane of the head and larger handle, than the lower part of it, at K; or, which is the ſame thing, that the angle, which the upper ſide of the mold-board, M E, makes with the beam, is greater than the angle, which the wriſt, B K, makes with the head; and hence the mold-board is not ſtraight; but is gradually projected outward, as it is raiſed upon the handle, from L to M. It is this caſting out of the mold-board that turns the furrow: and it may be caſt outward in ſuch a manner, as either to ſet the furrow upon its ſide, or turn it quite over on its back, as is found convenient.

If the wriſt is high ſet, the earth of the furrow will not touch the hinder part of the mold-board, but is raiſed and turned by the wriſt. In this caſe, the furrow which the plough makes, is no wider below, than the breadth of the head; the earth of the furrow is raiſed and turned over by the wriſt, as the plough moves forward; and the furrow is no wider above, than the part of the wriſt that turns the earth of it, is diſtant from the plane of the head. Thus, ſuppoſe that B K, ſee fig. 7. is ſet ſo high, that N is ſix inches above the under part of the head; if the plough goes ſix inches deep, then the furrow that the plough makes, will be, below, equal in wideneſs to B C, and, above, to N D. If the plough goes deeper, the furrow will be wider above than N D; if ſhallower, it will be narrower than N D.

THE mold-board in the common ploughs is, generally ſpeaking, almoſt quite ſtraight. In order to fit it to the plough, it is made of a thick piece of timber, and the lower part of it, at B, ſee fig. 10. where it is applied to the ſheath, and the upper part, at M, where it is fixed to the handle, are hollowed on the inner ſide. When the mold-board is thus hollowed on the inner ſide, if, by taking off from it, on the outer ſide, it is made equally thin in all places, then it is of the proper ſhape, as already deſcribed.

FIG. 11. repreſents the plough complete by joining together figures 6. and 10. in the ſheath E B; the wriſt B K is ſuppoſed to make an angle with the head A B, as in fig. 7. and the handles joined together, as in fig. 9.

IF the conſtruction of the plough is attended to, it will appear, in what manner in going it ſeparates, raiſes, and turns over the earth of the furrow. If it had no coulter, the earth would open above the middle of the ſoke, and in a line before the ſheath; but as the coulter opens the earth on a line with the left ſide of the head, if the ſoil has any coheſion, the earth of the furrow will be wholly raiſed from the left ſide, and as the ſoke moves forward, will be thrown on the right ſide of the ſheath, and by the caſting out of the mold-board, or the riſing of the wriſt, will be turned over. If the earth of the furrow, taken off by the coulter, is juſt equal in breadth to the under ſide of the head, and that part of the wriſt that is in a line with it, or as low ſet, then this earth is juſt wholly moved and turned; if it is leſs, then it is not only raiſed and turned, but alſo ſhifted a little to the right hand; if it is greater, the whole of it is not moved, but the under part on the right ſide remains firm.

We formerly obſerved, that the Scots plough is the beſt general plough, and on that account preferred it to any other at preſent uſed in Scotland. We did not intend however to aſſert, that it is perfect. Whoever attends to the ſtructure of it, the manner in which it ſeparates, raiſes, and turns over the earth of the furrow, will obſerve ſome defects. As the ſoke is high in the middle, and round on the ſides, as the point of it is in a line with the middle of the head, it is obvious, that a great force is neceſſary to raiſe the earth of the furrow; and as the ſheath is nearly in a line with the point of the ſoke, and to the right of the left ſide of the head, the earth of the furrow, as it is raiſed muſt ſtrike againſt the ſheath; and if it does not ſtick cloſe together, a part of it will fall to the left ſide, inſtead of being turned wholly to the right. Theſe are defects, for they make the plough heavy to draw; and beſides, this poſition of the ſheath makes the Scots plough improper for hoeing, as the earth that falls to the left, buries the young plants in the rows.

To remedy the defect ariſing from the ſoke, it is propoſed to make a ſoke ſtraight on the land-ſide, ſo as to be in a line with the land or left ſide of the head, and ſtraight alſo below, ſo as to be in a line with the under ſide of the head, ſloping on the furrow or left ſide, and alſo on the uppe ſide from the point, ſo as to make it a the root about ſeven inches broad, an three inches thick, at the ſame time ſloping all the way from the land to the furrow ſide, ſo as to form the furrow-ſide in to a ſharp edge. It is obvious, that this ſoke in going will meet with leſs reſiſtanc than the common ſoke, will raiſe the ear of the furrow wholly from the left ſide, and turn it as it is raiſed.

To remedy the defect ariſing from the ſheath, it is propoſed to bring the ſheath a little nearer the larger handle, and to fix another ſheath a little before it, to the left or land ſide of the head and beam, and fix the mold-board to this ſheath. It is obvious, if this is done, that the earth of the furrow, as it is raiſed by the ſoke, will be reſiſted by the mold-board only, and wholly turned to the right.

By this alteration of the ſoke which is propoſed, the point of it is brought exactly to the place of the point of the coulter in the common plough: this makes it neceſſary to change the poſition of the coulter, and to place the point of it in a line with the point of the ſoke a little above, or a little before it, or both, as found moſt convenient.

There is another thing ſuppoſed alſo to belong to the plough, and that is the

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bridle or muzzle. It is fixed to the end of the beam, and the cattle are yoked by it. The one commonly uſed is a curved piece of iron fixed to the beam by a bolt through it. See fig. 12. A B C is the curved piece of iron, A C the bolt by which it is fixed to the beam, D is the ſwingle-tree or croſs-tree, to which the traces are fixed, and B is a hook, or the cleek as it is commonly called, which joins the muzzle and ſwingle-tree.

THERE is another kind which is uſed by ſome. It is fixed to the beam by two bolts. It has notches by which the cleek of the ſwingle-tree may be fixed, either to the right or the left of the beam; and there are different holes for the hind bolt to paſs through, by which the draught may be fixed either above or below the end of the beam. See fig. 13. A B C D anſwers to A B C in fig 12. A D is the fore bolt, upon which the muzzle turns; on B C are four notches, betwixt any two of which the cleek of the ſwingle-tree may be fixed. When the cleek is fixed at B, the plough is turned towards the firm land, and takes off a broader furrow; or, as the ploughmen call it, the plough has more land. When the cleek is fixed at C, the plough is turned towards the furrow or the ploughed land, and takes off a narrower furrow; or, as the ploughmen call it, has leſs land. E and F are the holes on each ſide through which the hindmoſt bolt paſſes. When this bolt is put through the higheſt two, theſe holes being thereby brought to the middle of the beam, the fore part of the muzzle is raiſed above the beam, and the plough is made to go deeper; or, as the ploughmen call it, the plough has more eard: and when the bolt is put through the loweſt two, the fore part of the muzzle is thereby ſunk below the beam, and the plough is made to go ſhallower; or, as the ploughmen call it, has leſs eard. And thus, by changing the place of the cleek of the ſwingle-tree, or changing the poſition of the muzzle, the plough is made to take off a broader or a narrower furrow, or to go deeper or ſhallower, and a ſmall error in the original make of the plough rectified.

SOME are of opinion, that this muzzle is not proper when the plough is going upon land where there are many faſt ſtones. For when the plough ſtrikes againſt a ſtone, this muzzle being fixed by two bolts, and not having that freedom to move, or *that play*, as it is commonly called, which the common muzzle hath, the plough is in greater danger of being broken. But this ought not to be an objection againſt the uſing of this muzzle: for whenever the plough is going upon land where an accident of this kind is apprehended, this muzzle may be made to have the ſame play with the other, by taking out the hindmoſt bolt.

CHAP. VI.

Of the plough with the curved mold-board.

THE mold-board of the Scots plough, as has already been deſcribed, is not

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Fig. 5.

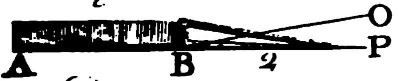
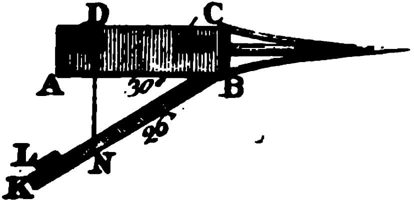


Fig. 7.



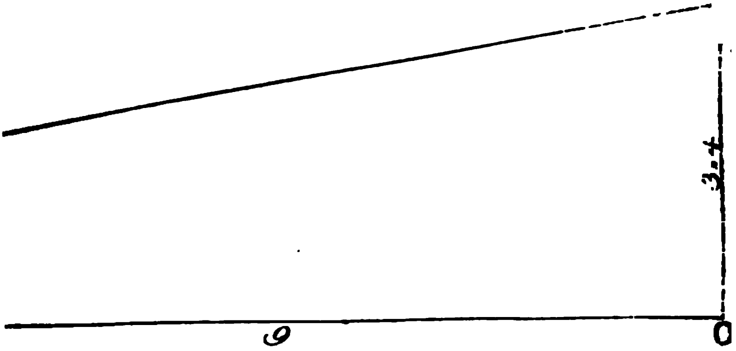
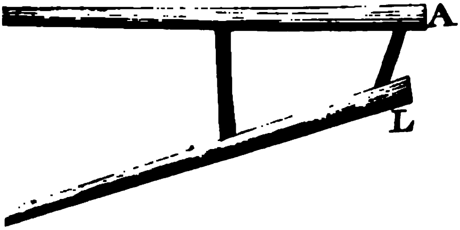


Fig. 9.



not quite ſtraight, but is caſt outward above, and more and more ſo as it approaches the leſſer handle.

Ploughs that have a curved mold-board, commonly have no wriſt, the mold-board ſerving for both. The under part of it, that ſerves in place of the wriſt, as it approaches the handle, becomes parallel to the plane of the head, and ſometimes after it has paſſed the handle, is made to turn a little inwards; and the fore part of it, which is ſtraight below, is curved more and more the farther up it comes, reſembling the bow of a ſhip.

If one mold-board is preferable to another, it muſt be for one of theſe two reaſons, either becauſe it throws the earth of the furrow more properly, or makes the plough more eaſily drawn.

It will not be amiſs that we examine the curved mold-board with reſpect to both theſe, and compare it at the ſame time with the common mold-board.

IT was obſerved, that the earth of the furrow taken off by the coulter, is raiſed by the ſoke from the left ſide, and as the plough moves forward, is thrown to the right ſide of the ſheath. Now, the uſe of the mold-board is to raiſe the earth, turn it over, and if it is taken off narrow, to ſhift it a little to the right hand. The common mold-board with the wriſt, if right made, does theſe things altogether and gradually; it gradually raiſes up the earth of the furrow; as it raiſes it up, it turns it over; and as it turns it over, it ſhifts it a little to the right hand, and leaves it either ſtanding on its edge or ſide, or turns it quite over, as it is itſelf caſt outwards above by the handle. The curved mold-board acts differently: as it is caſt out above in the fore part, it prevents the furrow from riſing, it turns it over ſuddenly, and if it needs to be ſhifted to the right hand, this is done after it is turned over. In land that eaſily breaks in pieces, the common mold-board ſeems to have the advantage; for as it raiſes the earth of the furrow higher than the other, it leaves it more looſe and open, and better expoſed to the influence of the air; but in land that is not eaſily broke, the curved mold-board ſeems to have the advantage; for by turning over the earth of the furrow ſuddenly, it is apter to tear it aſunder in turning it than the common mold-board, which turns it over more gradually; and by ſhifting it to the right hand, after it is turned over, is apt to bruiſe it. It is certain, that the earth of the furrow, by being turned over gradually, and ſhifted as it is turned, will continue whole in ſome ſoils, in which it will be broken, if turned over ſuddenly, and will be bruiſed, if ſhifted after it is turned.

The other thing mentioned, which makes one kind of mold-board preferable to another, is the making the plough more eaſily drawn. Let us then conſider the curved mold-board alſo with a view to this, and compare it at the ſame time with the common mold-board. It is obvious, that in this reſpect the common mold-board has the advantage; for though it may be allowed, that the friction made by the hind part of the mold-board is leſſened by its being curved, yet the friction in general is rather increaſed, as this is more than balanced by the greater reſiſtance which it meets with on the fore part, in turning the earth of the furrow. Some perſons have been led to imagine, that the curved mold-board makes the plough more eaſily drawn, from the reſemblance it has to that ſhape of the ſide of a ſhip, which, experience teaches us, paſſes moſt eaſily through the water: but certainly there is a great difference betwixt the motion of a body through a fluid, driven by the wind, acting upon places raiſed above the body, and the motion of a body through the earth, pulled by the end; and therefore there can be no juſt reaſoning from any analogy betwixt them *.

'Tis

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* There are a variety of reaſons for making a ſhip narrow behind; thereby the helm has the greater command; the centre of gravity is nigh the middle, and the keel placed parallel to the ſurface; and, no doubt, the friction is leſſened. There is alſo a good reaſon for making the fore part of a ſhip narrow below, and gradually to caſt outward above; this is not done becauſe it is the ſhape that goes with the greateſt eaſe through the water, but becauſe it is neceſſary

'Tis certain, that the curved mold-board, by turning the earth of the furrow ſuddenly by the fore part of it, meets with more reſiſtance than the common mold-board in that place; and if the earth is ſhifted to the right hand, the curved mold-board muſt preſs upon it after it is turned, as the plough moves forward, which makes the friction on the hind part of the mold-board, perhaps, nearly equal to that upon the common mold-board when it turns the furrow. To illuſtrate this, let A B repreſent the firm land; ſee fig. 14.; C D the earth of the furrow already laid up to the ploughed land; G H the earth of the furrow which the plough is taking from the firm land; I K the ſame earth laid to the ploughed land; E the furrow which the plough made, when

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ſary to prevent the head of the ſhip from being buried, and to keep the keel parallel to the ſurface, while the ſhip is ſailing. If this was a proper place, it might eaſily be ſhown, that the force impreſſed upon a ſhip by the wind at the top of the maſts, would force the head under water, if it was as narrow above as below; and that the reſiſtance which the head meets with, by being caſt out above, prevents it from going down, and makes the ſhip ſpring forward.

it laid up the earth C D; and F the furrow made, when it laid up the earth I K. Let L repreſent the place where the curved mold-board turns the earth of the furrow. Now, it is obvious, that the mold-board, in moving forward, muſt preſs the earth K L, in laying it cloſe to the earth C D; whereas, if the earth is not turned over at L, but only raiſed up, and turned over gradually, as it approaches the earth C D, thereby it has freedom to move, and does not give ſuch reſiſtance to the mold-board, as when turned over at L. In this reſpect, then, the curved mold-board ſeems to have no advantage over the common mold-board; on the contrary, ſeems to make the plough rather heavier to draw.

It is neceſſary to obſerve, that in comparing the mold-boards with each other, we have ſuppoſed the ſheaths to which they are fixed in the ſame poſition: for the effects of both are different, according to the poſition of the ſheath. If the ſheath to which the curved mold is fixed ſlopes much backward, ſo as to make the angle contained by it and the head much leſs than ſixty degrees, then the earth is ſufficiently raiſed before it touches the upper part of the mold-board, and is turned gradually as it is raiſed; ſo that a curved mold-board with a ſloping ſheath has the ſame effect as the common mold-board with a more upright ſheath.

CHAP. VII.

Of the plough with the feathered ſoke.

THE difference betwixt the feathered ſoke and the common ſoke, will be beſt underſtood by comparing them together in the figures. Fig. 15. is the common ſoke, and fig. 16. is the feathered ſoke *.

It is obvious, from the conſtruction of this ſoke, that it meets with greater reſiſtance than the common ſoke; for it is broader before, and does not ſlope ſo gradually, and therefore makes the plough not ſo eaſily drawn. However, it is not ſo in every caſe. When the plough takes off the earth of the furrow broader than that part of the ſoke that goes upon the head, then it is more eaſily drawn with the feathered ſoke than with the common ſoke; for the firm earth which the common ſoke leaves to be opened by the wriſt, is opened by the feather of the other ſoke, which is done much more eaſily.

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* The feather of the ſoke is called by the Engliſh writers, *the fin of the ſhare.*

NEITHER is the plough with the feathered ſoke heavier to draw in every kind of land. In lea, or land that has upon it a tough ſward of graſs, this ſoke makes the plough eaſier to draw. The reaſon of this is obvious: The roots of the graſs go beyond the reach of the plough; and it is much eaſier to cut theſe, as the feathered ſoke does, than to tear them aſunder, as is done by the common ſoke. The plough, then, with this ſoke is very proper for opening up graſs-ground.

BUT the plough with this ſoke is not

only more eaſily drawn than the plough with the common ſoke, in ſome lands, but alſo in ſome lands makes better work. In lands where there are root-weeds, it deſtroys theſe weeds much more effectually; for many of the roots, which the common ſoke ſlips by, or paſſes over, are cut by this feathered ſoke, and thereby the weeds themſelves deſtroyed. But then, it is to be obſerved, that the common ſoke has greatly the advantage in ſtony land; and of this kind is a great part of our land in Scotland: for the common ſoke, by the ſharpneſs of its point, and the gentleneſs of its ſloping towards the head, eſcapes many ſhocks from the ſtones, which would put the plough with the feathered ſoke out of its direction, and endanger its being broken to pieces.

It is proper to add, that in fitting this ſoke to the head, it is neceſſary to turn the point from the land, or a little to the right hand. This is contrary to what was before directed, with reſpect to the common ſoke. But the reaſon is obvious:

vious: This ſoke, if fitted on quite ſtraight, will have its left ſide exactly in a line with the left ſide of the head, and parallel to the direction of the draught, and therefore can receive no reſiſtance from the land-ſide: all the reſiſtance it meets with is from the furrow-ſide, which gives the plough a tendency to go into the land; and to prevent this, it is neceſſary to turn the point of the ſoke a little towards the furrow: this leſſens the reſiſtance from the furrow-ſide, and makes it meet with ſome reſiſtance from the land-ſide.

CHAP. VIII.

Of the wheeled plough.

THE wheeled plough uſed in Scotland is different from the one uſed in England, as deſcribed by the writers on huſbandry. The Scots wheeled plough is formed by adding the wheels to the old Scots plough, and giving it a curved mold-board, and feathered ſoke, as perſons fancy. Theſe have already been conſidered, 192

Fig. 1

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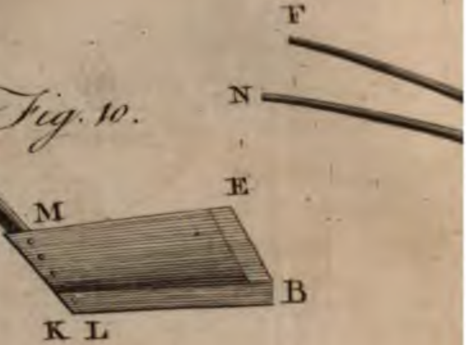
Fig. 10.



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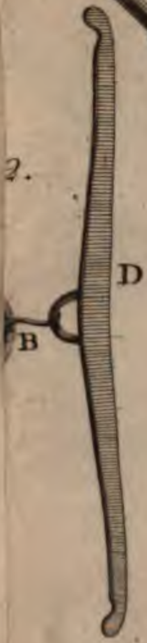

Fig. 13.

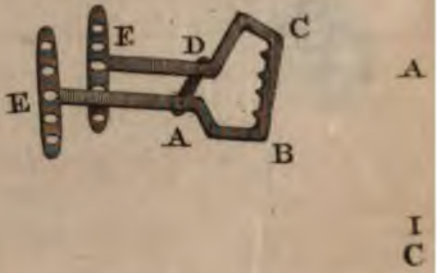

Fig. 15.

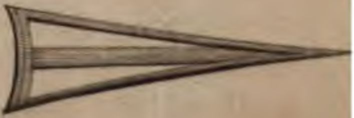

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Fig. 11

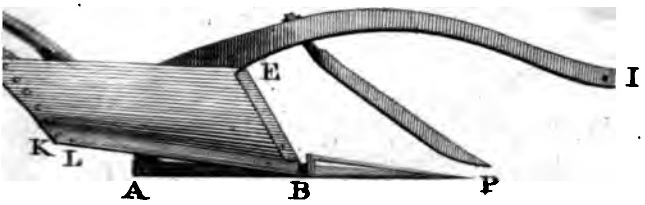


Fig. 14.

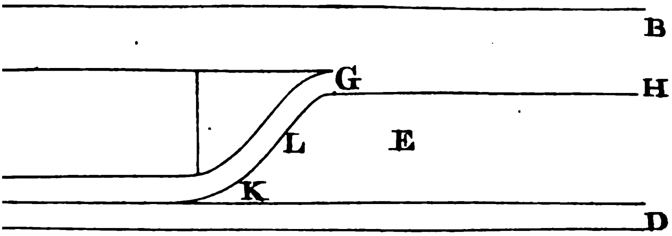
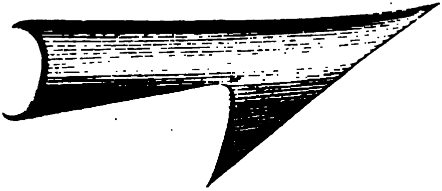


Fig. 16.



Thos. Phinn Sculpt.

lered, and therefore the only thing which e are here to inquire into, is, the advan- ge or diſadvantage of the wheels.

Some perſons are of opinion, that heels to a plough leſſen the draught. When the beam is raiſed and placed up- n an axletree with wheels, by the draw- ng of the cattle there is a preſſure upon the wheels. In proportion to this preſſure, the friction of the plough is leſſened; and in proportion as the beam is raiſed, is this preſſure increaſed. Now, if the ſtrength neceſſary to overcome the friction is greater than the ſtrength neceſſary to overcome the preſſure, the draught muſt be leſſened. Was it not for the weight of the machinery, which is an additional preſſure upon the wheels, the ſtrength required to overcome the preſſure, would be to the ſtrength neceſſary to overcome the friction, as the circumference of the wheels is to the axletree. But as, in the common wheeled plough, the preſſure upon the wheels is but ſmall, the friction cannot be leſſened in any great degree; and therefore the wheels in this reſpect are of n conſiderable advantage to the plough.

In other reſpects the wheels, no doub are of advantage: they regulate th plough, make it go to a certain depth and take off the earth of the furrow of fixed and certain breadth, and they mak the plough very eaſily managed.

One of the wheels goes in the furrow, and the other on the unploughed land the beam reſts upon the carriage of th wheels; and as it is thereby kept at a equal diſtance from the ſurface, the plough muſt be kept alſo at an equal and certain depth.

One of the wheels is always confine to the bottom of the furrow; this make the plough always take off an equal an certain quantity from the land.

Th [illegible] certa [illegible]

ſo little attention is neceſſary from the man that holds the plough, that he may alſo drive when two horſes are ſufficient for the draught; for having nothing to do but keep the plough even, he may uſe one of his hands when neceſſary for the direction of the horſes.

But we may mention as another advantage of the wheels, that they make it eaſy for the ploughman to keep the ridges ſtraight. A farmer, after he has laid out a field in ſtraight ridges, finds that few of the ordinary ploughmen can keep them in this ſituation: and indeed it is ſomewhat difficult to do this; for, in order to it, the firſt furrow of the ridge muſt not only be drawn quite ſtraight, but alſo the earth of every ſucceeding furrow muſt be equally broad in all parts of the ridge. If the firſt furrow is drawn ſtraight, that part of the ridge where the plough begins will indeed be ſtraight; but if the plough takes off the earths of the furrows broader at one end than another, that part of the ridge where the plough ends, will be crooked. Now, it requires great attention in the ploughman to prevent the cattle from going in ſuch a manner, as to make the earths of the furrows either broader or narrower at the ends of the ridge than in other parts of it; for to the hand to which they are accuſtomed to turn, they naturally tend before they reach the end of the ridge; and this makes the plough, according as the cattle turn, take off more or leſs than in other parts of the ridge. The wheeled plough in a great meaſure prevents this; for as one of the wheels goes in the furrow, it cannot be pulled out without difficulty; and any attempt to do this makes ſuch an alteration in the going of the plough, as to call the attention of the ploughman.

THESE are the advantages of this plough: it has its diſadvantages likewiſe; when compared together, they will probably be found pretty nearly to balance each other.

IT has too much machinery, which in every

very inſtrument is an inconvenience. For the more machinery there is in any inſtrument, it is the more liable to be broken, and the more difficult to get it mended.

It is not proper for ploughing acroſs ridges. When the cattle have paſſed the furrow, and are going up towards the crown, the draught being thereby raiſed, while the plough is on the deſcent, the fore part of the plough is raiſed likewiſe, and the plough itſelf, perhaps, brought quite out of the ground: and, on the other hand, when the cattle have paſſed the crown, and going down towards the furrow, the direction of the draught being thereby made lower, the plough is forced in too deep. This does not happen to the common plough; for the ploughman can either reſt upon the handles, or lift them up a little, as he finds it neceſſary; and thereby make the plough go deeper, or ſhallower, than otherwiſe it would do.

This plough is likewiſe troubleſome,

when ploughing narrow ridges; for it muſt be frequently altered in ploughing out a ridge. The wheel that goes in the furrow being higher than the other, when both wheels are going upon the ſurface, the beam muſt be changed from its ordinary poſition, and placed in ſuch a manner, as to keep the plough even, and to make it go a little deeper than ordinary. When a furrow is made for the wheel to go in, the beam muſt be changed to its ordinary poſition; and when the ridge is near finiſhed, ſo that both wheels are going in furrows, the poſition of the beam muſt be again changed to keep the plough even, and to prevent it from going in too deep.

IT will not be improper to mention another thing, which ſome perſons reckon an advantage in this plough, but which, when ſeriouſly conſidered, will appear rather a diſadvantage. It is ſaid, that, where the ſoil is ſhallow, the plough being fixed to a certain depth, can be made to take up all the good earth, without ſtirring the till; whereas, when this is left to be regulated by the ploughman, with a common plough, they are ſo inattentive, as to leave good ſoil in ſome places, and turn up till in others. At firſt ſight, one naturally thinks, that, in this reſpect, the wheel-plough is preferable; but, upon trial, the reverſe is found true. The reaſon is this: There is ſcarcely a field where the ſoil is equally deep in all places; if the ridges are high, it is always deeper in the crowns than in the furrows. If the wheeled plough, therefore, is ſet in ſuch a manner, as not to touch any of the till, where the ſoil is ſhallow, it will not reach the good ſoil where it is deep: and, on the other hand, if it is ſet in ſuch a manner, as to reach the good ſoil to a conſiderable depth, it will turn up the till where the ſoil is ſhallow. This plough then is not ſo proper an inſtrument for ploughing land of this kind, as the common plough; which, from its make, is ſet to a certain depth, and will go at that depth, if not incommoded; but, however, can be made to go deeper, or ſhallower,

lower, by the ploughman, as he ſees neceſſary.

CHAP. IX.

Of the four-coultered plough.

THIS plough is greatly recommended by ſome writers on huſbandry, ſince Mr Tull's time *.

IN England, it is, perhaps, uſed with ſucceſs; but the attempts to introduce it into Scotland have hitherto proved unſucceſsful. After ſeveral trials to no purpoſe, thoſe that were fondeſt of it, have been obliged to give it up.

THE deſign of treating of this plough here, is to point out its defects; or, rather, to ſhow the reaſons which have rendered it impoſſible to plough with any of this kind, as yet tried, in Scotland This may be of uſe to thoſe who are ſtill deſirous of introducing this plough. For, if it is known where the defects lie, we will, at leaſt, be able to judge if it is poſſible to remove them.

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* See Mills's Du Hamel, and Complete body of huſbandry.

Any perſon that conſiders the conſtruction of this plough, particularly the three additional coulters, will immediately obſerve, that it muſt be very difficult, if not impoſſible, to make it go right. So many coulters in the ground all at once muſt meet with many obſtacles; and theſe obſtacles will give the plough different directions, according to the different places of the coulters, to which the reſiſtance is given: and theſe different directions, given, perhaps, at the ſame time, or ſuddenly after each other, muſt greatly incommode the going of the plough. Beſides, it is difficult to place the planes of the coulters exactly parallel to each other; and, if this is not done, they will be continually acting upon the plough in different directions. We may obſerve likewiſe, that if this plough is uſed for breaking up graſs-ground, which is the chief deſign of it, the oblique poſition of the coulters will raiſe the turf in ſuch a manner, as to entangle it betwixt them, and thereby entirely prevent the plough from going. This will the more readily happen, if the beam is near the ſurface, and the coulters ſhort: and, on the other hand, if the beam is at a diſtance from the ſurface, and the coulters long, the obſtacles which they meet with will have the greater influence on the plough, and the coulters themſelves be the more eaſily broken, or put out of their place.

Some perſons who have made trial of this plough, have had it made without wheels: but this certainly was ill-judged: for the wheels ſeem abſolutely neceſſary for regulating the plough when going, and preventing the different ſhocks which it receives, from putting it out of its direction.

Some perſons have tried this plough upon land, the ſurface of which was very hard: but this was likewiſe ill-judged;

for, the harder that the ſurface is, the coulters meet with the greater reſiſtance, and the plough is in the greater danger of being turned out of its direction.

THESE things are mentioned, not to deter perſons from making further trial of this plough; but to hint how the trial may be made, in ſuch a manner as has the beſt chance of ſucceeding. In order to this, the following things ſeem neceſſary: That the plough be made with wheels: that the planes of the coulters be placed exactly parallel to each other: that the firſt coulter be ſet almoſt perpendicular, and go not above two inches deep; that the ſecond ſlope but a little, and go but a little deeper; that the third ſlope a little more, and go a little deeper than the ſecond; and that the plough be uſed on land where there are feweſt obſtacles. The kind of land that ſeems moſt proper for it, and which too is moſt difficult to reduce, is ſoft meadow-land, that is free from ſtones, and has upon it a tough ſward of graſs.

The ſoftneſs of this land gives the leaſt reſiſtance to the coulters, and the leaſt diſturbance to the plough.

It is ſomewhat ſurpriſing, that perſons have not tried a plough with two coulters, ſuch as is deſcribed by ſome of the Engliſh writers on huſbandry, before they attempted one with four. If two can be placed in ſuch a manner as to anſwer, a third may then be added, and afterwards a fourth. But, if it is found that two are attended with inconveniencies, it is vain to attempt four.

In the directions given by Mr Tull, for making the four-coultered plough, it appears that a furrow ten inches broad, is taken off by it; which, to be divided into four by the coulters, muſt require a great ſtrength to the plough. If the plough with two coulters is made to take off a furrow ſix inches broad, the work will be almoſt as well done, and with much leſs ſtrength. This plough will not, indeed, do near ſo much work as the four-coultered plough; but little leſs than is done in the common way of clean ploughing, in thoſe parts of the country where this work is beſt performed.

The chief deſign of this four-coultered plough, is to break up graſs-ground. 'Tis certain that the ſward is not ſufficiently torn aſunder, and broken, when the land is ploughed in the ordinary way; and therefore any contrivance, to facilitate the reducing this kind of land to a proper tilth, is, no doubt, a great improvement. Trench-ploughing, which is propoſed by ſome, where the ſoil will allow, ſeems to be more proper for this, than ploughing by the four-coultered plough. But this ſhall be conſidered in its proper place.

CHAP. X.

Of the iron plough.

This plough is formed upon the model of the old Scots plough. The ſeveral parts of it are ſhorter, and the head and ſoke are of one piece, like the Engliſh ploughſhare. The plate, that is in the place of the mold-board, may be made either plain or curved; and the ſhare may be made either with or without a fin. The only things to be conſidered, in comparing this plough with the old Scots plough, are the advantages, or diſadvantages, ariſing from its being made of iron, and having ſome of its parts ſhorter.

IT is not propoſed here to compare theſe ploughs, with reſpect to the expenſe of purchaſing; or to conſider, whether the laſting of the iron plough, and the value of the iron, when the plough is become uſeleſs, do not ſufficiently balance the leſs expenſe of the common plough at the firſt purchaſe. The only things which we are to conſider, are, which of the two is moſt eaſily drawn, and makes the beſt work.

IT is certain, that this plough is more eaſily drawn, than any other uſed in Scotland. It is lighter than the common plough, when equally ſtrong. The head and other parts of it that go in the land, being ſhorter and narrower, there muſt be leſs friction; and the fore part of the head, or what, in England, is called the *neck of the ſhare*, being narrower, and the ſheath being thinner in the edge, it muſt meet with leſs reſiſtance. And it may be added, that this plough, being made of iron, and each part exactly fitted to another, the earth does not ſo eaſily ſtick to it, and clog it while going.

But thoſe things which make this plough eaſier drawn than the common plough, are, in other reſpects, real defects. The lightneſs of it, and particularly the ſhortneſs of thoſe parts that go in the land, which are the principal things that render it eaſy drawn, make it go very unſteadily where it meets with obſtructions. The heavier that the plough is, and particularly the greater the diſtance is betwixt the end of the head and point of the ſoke, it is the more difficult to force it out of its direction; and, on the contrary, the lighter that the plough is, and the ſhorter this diſtance, the plough is the more eaſily turned to a ſide. Now, as this plough is ſo much lighter, and ſo much ſhorter, than the common plough, it muſt be ſo much the more unſteady. The ſmall diſtance, from the point of the ſoke to the point of the coulter, makes this plough likewiſe more unſteady than the common plough. For, the ſmaller that this diſtance is, the opener is the land in which the point of the coulter goes; and therefore the coulter itſelf can make the leſs reſiſtance, when the ſoke meets with any ſhock that tends to put the plough out of its direction [*].

THE advantage then of this plough is, that it is eaſily drawn; the diſadvantage is, that it is eaſily put out of its direction. Theſe things point out the kind of land for which it is moſt proper. It is not proper for ſtony land, or land which riſes in hard clods; but it will anſwer very well in land that is ſoft, and in which there are few things to put it out of its direction. * It may be added, that the better the lands are improved, this plough will be found the more uſeful.

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[*] Every common ploughman will tell you, that, when the plough-irons are ſhort, his plough *goes kittle*. By this he means, that it is eaſily turned aſide, and is difficult to manage. He knows likewiſe that this is the caſe, when the points of the irons are near each other. The iron plough is in the ſame ſituation with the common plough, when its irons are ſhort, and the points of them near to each other; it is eaſily turned out of its direction, and is troubleſome to manage.

There is one thing that will make it very difficult to introduce this plough; and that is, It is very inconvenient for the ploughman: for he is obliged to carry it to the ſmithy, at, perhaps, a conſiderable diſtance, whenever any thing about it breaks, or goes wrong; or even when what are commonly called the *plough-irons* need to be laid, or ſharpened, which is frequently happening when the land is hard. When any part of the common plough breaks, which can be mended without taking the plough aſunder, the wright goes to the field and does it: and, when the irons need to be laid or ſharpened, the ploughman takes them off. But none of theſe things can be done with the iron plough. Whenever it needs any thing to be done to it, the plough itſelf muſt be carried to the ſmithy. This, as it is an inconvenience to the ploughman, will frequently likewiſe be inconvenient to the maſter. For there are many ploughmen that are diſpoſed, from lazineſs, to work with an ill-going plough, rather than be at ſo much trouble as carry it to a place at any diſtance.

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* This plough is proper not only for all kinds of light land, that are free from ſtones, but alſo for clay-land, when not too dry. When clay is ſo ſoft, as to turn over with whole furrow, the iron plough goes very eaſily through it; but when it is ſo hard as to riſe in clods, the ſhocks that theſe clods give the plough continually incommode it.

CHAP. XI.

Of ſome general things to be obſerved in making the Scots plough.

THIS plough has already been particularly deſcribed, and the uſes of its different parts ſhown. By attending to theſe things, it may be known when it is right made. However, it will not be amiſs to mention ſome of the principal things neceſſary to be attended to; and we ſhall endeavour to do this in ſuch a manner; as to be underſtood by thoſe who are chiefly concerned about ploughs.

In making this plough, care muſt be taken that the big ſtilt and the ſheath be fixed in ſuch a manner to the head, that when the beam is fixed to them, it may be exactly in the ſame direction with the head, and point neither to the land-ſide nor the fur-ſide *. If the beam points to the fur-ſide, the plough will have too much land; and if it points to the land-ſide, the plough will have too little land. When an error of this kind happens, the wright will endeavour to rectify it by the way of fitting on the ſoke, and the ploughman by the way of putting in the coulter. But if the error is great, the plough thus

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* There is no matter though the beam points a little to the fur-ſide; for the land that is thereby given to the plough, is in ſome meaſure balanced by the ſoke, having leſs reſiſtance given from the fur-ſide than from the land-ſide.

ſet right by the way of fitting on the ſoke, will be heavy to draw, will go very kittle, and be in danger of breaking. The reaſon of this is obvious: The plough goes with its ſhoulder foremoſt inſtead of the points of the irons; this makes it heavy to draw: the head and the ſoke bear againſt one another; this makes it go kittle: and the draught not being along the head, is in danger of breaking the ſheath, or tearing the joints. If the plough is ſet right by the way of putting in the coulter, the plough will be heavy to draw, and the coulter in danger of breaking, or being put out of its place: for the coulter not going with its edge foremoſt, meets with greater reſiſtance, and thereby not only incommodes the plough, but is alſo in danger of breaking or looſing the wedges by which it is fixed to the beam.

Care muſt be taken likewiſe to place the beam in ſuch a manner as to give the plough neither too much nor too little eard. If the beam is placed too high, the plough will have too much eard; and if it is placed too low, the plough will have too little eard. The wright determines the poſition of the beam in this manner: After he has fixed the big ſtilt and the ſheath to the head, and fitted the beam to the big ſtilt and the ſheath, he applies a rule along the under ſide of the head, which he extends forward as far as the point of the beam, and then he meaſures the neareſt diſtance from the rule to the place of the beam through which the hole is to be bored for the bolt of the muzzle, and he adjuſts the beam ſo as to make this diſtance greater or leſſer, according as the plough is to be yoked. If the plough is to be drawn by oxen, he makes this diſtance greateſt; if by two horſes abreaſt, he makes it leſs; and if by four horſes, two abreaſt, he makes it leaſt of all. If he finds he has committed any error in this, he endeavours to rectify it by the way of fitting on the ſoke. If the error is great, he ſhould not be allowed to do this, but ſhould be obliged to alter the poſition of the beam, which may be done with very little trouble. If the error be rectified by the way of fitting on the ſoke, the plough will either go upon the points of the irons, which will make her go very kittle, and at the ſame time make a bad fur; or the head will go lower than the point of the ſoke, which will make the plough very heavy to draw.

IN fitting on the ſoke, care muſt be taken to make it ſtraight with the head, and the coulter muſt be placed ſo as the point of it may be as low as the point of the ſoke, and as far forward, or a little before it, and, at the ſame time, a little to the land-ſide, that ſo it may be in a line with the land-ſide of the head. This poſition of the coulter gives the plough a little more land; but this is balanced by the plough being confined on the land-ſide, and at liberty on the fur-ſide, which naturally gives it leſs land. If this poſition of the coulter is overbalanced by the freedom of the plough on the fur-ſide, it is neceſſary to give the plough more land by the ſoke; for it is improper to turn the coulter further to the land-ſide than to be in a line with the land-ſide of the head.

It has been ſaid, that if there is an error in the original make of the plough, the wright endeavours to rectify it by the way of fitting on the ſoke. He does it in this manner: If the plough has too much land, he turns the point of the ſoke to the fur-ſide; if it has too little, he turns the point of the ſoke to the land-ſide; if the plough has too much eard, he turns the point of the ſoke a little upwards; and if too little, he turns it a little downwards; and if the head will not allow any alteration, he gives directions to the ſmith to bend the ſoke to the land-ſide, or to the fur-ſide, upwards, or downwards, as is neceſſary, which ſerves the ſame purpoſe.

It has been obſerved likewiſe, that the ploughman can give the plough more or leſs land by the coulter. The coulter is fixed to the beam by wedges: by theſe wedges he can turn the point of it either to the land or from it as he pleaſes; or he can turn the fore edge of it a little towards the land, or towards the furrow. The turning the point or fore edge of the coulter to the land gives the plough more land, and the turning them from the land gives it leſs.

CARE muſt be taken likewiſe to place the wriſt and mold-board in a manner proper for the deſign of the plough. The plough that is generally moſt approved of, and makes the beſt work, is the one that makes a redd fur below, and ſets the fur taken off juſt upon its edge; for by making a redd fur below, the whole land is clean ploughed, and by ſetting the fur juſt on its edge, it is left opener, and the harrows make greater impreſſion than if it is turned upon its back. To make the plough do this on light land, that falls in pieces in turning, the wriſt muſt be ſet low and wide; but in ſtiff land, that goes over with whole fur, if the wriſt is ſet in this manner, the plough will be heavy to draw, and the fur taken off in danger of falling back: for this kind of land therefore

fore the wriſt ſhould be ſet a little higher and narrower.

In gathering ſteep ridges, it is neceſſary that the mold-board be caſt out very much above, or the wriſt very high ſet; for without the one or the other of theſe, the plough will not be able to turn the fur to the brae. Theſe are neceſſary likewiſe, when it is intended that the fur ſhall not be ſet on its edge, but turned upon its back, as is ſometimes found proper. In every caſe, care muſt be taken that the mold-board be caſt ſo far outwards above, as to turn the furrow ſufficiently; for if the fore part of the wriſt makes the fur well redd below, and the mold-board does not caſt it well out above, having no foundation to ſtand upon, it will fall back again behind the plough.

If the farmer attends to theſe things, he will be able to diſcover where the error lies, if the plough does not pleaſe him in going, and to give directions to his wright how to rectify it. By frequent trial he will alſo find out the exact proportions of the different parts of the plough, and will be able to give directions how to make one to go in what manner he pleaſes.

CHAP. XII.

Of the methods of yoking cattle in ploughs.

HORSES and oxen are the animals uſed for drawing ploughs. Sometimes the one, ſometimes the other, and ſometimes both together. It is impoſſible to determine which of theſe is the moſt proper. This depends upon the kind of food moſt eaſily obtained, the other kinds of work required, and the expenſe of breeding, or purchaſing. If the real labour is to determine this without any other conſideration, then oxen are to be preferred; becauſe as they ſtand to the draught, they will overcome a reſiſtance which horſes will yield to.

As it cannot be determined, what kind of cattle are moſt proper for the plough;

ſo neither can it be determined, what number is neceſſary. This depends upon the ſtrength of the cattle, and the nature of the ſoil. The number varies according to the work in which the plough is to be employed, and often according to the cuſtom of the place, and fancy of the farmer *.

THE methods of yoking cattle in ploughs vary almoſt as much as the number uſed †. Some of them at firſt ſight are

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* All the following varieties are uſed: two horſes; three horſes; three oxen and one horſe; two oxen and two horſes; four horſes; two oxen and three horſes; four oxen and one horſe; ſix oxen; four oxen and two horſes; ſix oxen and one horſe; eight oxen; ſix oxen and two horſes; and four oxen and four horſes. The four oxen and one horſe, or the ſix oxen and one horſe, are only uſed in a ſtrait, when another horſe cannot be eaſily procured. The cuſtom of uſing three oxen and one horſe is but lately introduced, and is obſerved in very few places: every one of the others mentioned is the eſtabliſhed cuſtom in ſome part of the country.

† The two horſes are in ſome places yoked abreaſt, and in others before each other; the three horſes all abreaſt, two abreaſt and one before, or all in a line; the three oxen and one

are ſo awkward, that it is needleſs to conſider them. The only thing worthy of being inquired into, is, whether the cattle ſhould be yoked in pairs, or in a line before each other? We ſhall therefore conſider the advantages and diſadvantages attending each way, and compare them together.

THE moſt common way of yoking cattle in ploughs is in pairs. There are ſome diſadvantages attending this way that are obvious. In ploughing the furrows betwixt ridges, the land-cattle go upon the ploughed land, and tread it down with their feet: this, eſpecially if the land is wet, hurts it very much.

THERE is another diſadvantage very obvious. When there is but as much of

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one horſe all in a line; the two oxen and three horſes, the oxen abreaſt behind, and the horſes abreaſt before; the four oxen and one horſe, and the ſix oxen and one horſe, the oxen in pairs, and the horſe before; the ſix oxen, the four oxen and two horſes, the eight oxen, the ſix oxen and two horſes, and the four oxen and four horſes, in pairs; the four horſes all abreaſt, in pairs, or all in a line.

the ridge unploughed as to allow the land-cattle to go upon it with difficulty; they are frequently either going into the oppoſite furrow, and thereby giving the plough too much land; or, which is worſe, they are juſtling the furrow-cattle upon the ploughed land.

To remove theſe inconveniencies that attend the ploughing with the cattle yoked in pairs, ſome yoke them in a line before each other. It is obvious, that cattle yoked in this manner, going always in the furrow, neither tread upon the ploughed land, nor juſtle one another. In theſe reſpects the yoking the cattle in a line before each other, ſeems to have the advantage.

It is to be obſerved, however, that this method is not quite free from inconveniencies. When examined, it may perhaps be found attended with as great inconveniencies as the other.

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go all in the furrow. This makes it neceſſary to give the plough more land than ordinary, either by the ſoke or the muzzle: for if this is not done, the head and ſoke being in the ſame direction with the beam, and the cattle yoked to the middle of it, the plough will directly follow the cattle, without taking any thing off from the land. Now, it is inconvenient to be obliged to give the plough land either by the ſoke or muzzle; for, when the ſoke is turned out of the plane of the beam, it makes the plough heavy to draw; and when the muzzle puts the draught too much to one ſide of the beam, it prevents the plough from going upright *. The yoking the cattle in pairs is attended with none of theſe inconveniencies: for, in this caſe, the quantity of land, which the plough has naturally,

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* It is obſerved, that when by a broad muzzle the draught is removed to a certain diſtance from the beam on either ſide, the deſign is fruſtrate. For the plough is ſo much turned to one ſide, as to loſe as much by the direction of the irons, as is gained by the breadth of the muzzle.

when right made, is ſufficient to make it take off a proper furrow.

THERE is another inconveniency that attends yoking cattle in a line, ariſing from the nature of the animals. Horſes and oxen, like men, love their eaſe, and are diſpoſed to throw the burden upon their fellows. This they have a better opportunity of doing when yoked in a line before each other, than when yoked in pairs. When yoked in a line, each pulls by the traces of the one behind him; and therefore, though it may be known when the foremoſt neglects his work, by the ſlackening of his traces, yet it cannot be known when any of the reſt neglect their work; for though one of them does this, yet by the pulling of the one before him his traces may be fully ſtretched. But this is eaſily diſcovered, when the cattle are yoked in pairs; for then every one of them has a ſeparate draught. The goadman or driver knows, by the poſition of the yokes or croſs-trees, whenever one of them does not draw equally with his fellow; and the ploughman perceives, by the going of the plough, whenever any of the two pairs does not draw equally with the other *: for if the pair that goes foremoſt neglect their work, the plough is pulled out of the ground; and if the pair that go hindmoſt neglect their work, the plough is pulled in too deep. The reaſon is obvious; the plough is made to go at a proper depth, when the two forces by which different directions are given the plough, act at the ſame time. If one of them then ſhould ceaſe to act, the plough cannot go right. If the foremoſt pair ſhould ceaſe to draw, the plough having too little eard for the direction of the draught of the hindmoſt pair, will come out of the ground: and if the hindmoſt pair ceaſe to draw, the plough having too much eard for the direction of the draught of the foremoſt pair, will go in too deep. This does not hold in an ox-plough: for as the ſoam by which the foremoſt pair draw is fixed to the yoke of the hindmoſt pair,

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* A horſe-plough is here meant, and it is ſuppoſed that there are only two pair in the plough.

the whole force applied to the plough is in the ſame direction; and therefore, though any of the pairs ceaſe to draw, there is no alteration in the going of the plough.

There is yet another inconveniency that attends the common way of yoking cattle in a line before each other. When the fore cattle are all yoked to the traces of the hindmoſt, it is obvious, that as the beam, to which the draught is fixed, is much lower than his ſhoulders, by which the reſt pull, ſuch a weight muſt be laid upon his back or ſhoulders as muſt render him incapable of giving any aſſiſtance *. Beſides, as the whole force is applied in the direction of the traces of the hindmoſt horſe; it cannot have ſuch influence on the plough, as when a part of it is in a direction more horizontal. When a body is to be moved

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* Perſons that yoke cattle in a line are obliged to put a kind of ſaddle betwixt the back of the hindmoſt and the back-rope; this indeed prevents the horſe's back from being galled, but does not ſave him from the weight.

forward in any direction, the nearer that the direction of the force applied approaches to the direction of the body, it acts with the greater influence. And therefore, as the plough moves horizontally, and as the direction of the united draught of a plough with the cattle yoked two abreaſt, is more horizontal than the direction of the draught in a plough with the cattle yoked in a line, the ſame force applied will have greater influence.

When theſe two different ways of yoking cattle in ploughs are thus conſidered and compared together, it is difficult to determine which ought to be preferred. Each of the two ſeems preferable to the other in a certain ſituation. When the land is ſtiff and the labour ſevere, the yoking the cattle in pairs ſeems preferable, as it is certainly the ſtrongeſt draught; and when the land is wet, and in danger of being much hurt by the treading of the cattle, the yoking them in a line before each other ſeems preferable; as thereby they are confined to the bottom of the furrow, which is the firmeſt part of the land, and prevented from doing harm.

When a perſon uſes two or more ploughs, it is a very proper way to have one with the cattle yoked in a line, and the reſt with the cattle yoked in pairs. The ploughs with the cattle yoked in pairs continue as long as the land-cattle have room to go eaſily upon the firm land; and the plough with the cattle yoked in a line, follows, and clears up the furrows. In this way the cattle yoked in pairs do no damage, and the cattle yoked in a line are never uſed but where they are of real benefit.

To perſons that incline to yoke the cattle in a line before each other, it will not be amiſs to point out a way to remove the inconveniency laſt mentioned, and ſhow how the cattle may be yoked ſo as to lay no additional weight on the back or ſhoulders of the hindmoſt horſe, and to make the direction of the draught more horizontal. This is done by making the traces of the horſe next to the plough but one very long, and fixing them, not to the ſhoulders of the horſe behind him, but to the croſs-tree, and by fixing the traces of the horſe before him, not to his ſhoulders, but to his traces at the place where the back-rope is fixed. By this the hindmoſt horſe is delivered from the burden laid upon him in the other method, as his draught is entirely independent of that of the reſt. There is indeed ſome weight laid upon the horſe immediately before him, to whom the others are yoked. But this is but ſmall; for his traces are nearly in the ſame direction with theirs, and they are yoked to him at a place lower than his ſhoulders. By this, likewiſe, the direction of the united draught is more horizontal, when there are three or more horſes yoked; it is even more horizontal than when the cattle are yoked in pairs. In a four-horſe plough, yoked in pairs, the two forces are equal; but in a four horſe-plough, yoked in this manner, the force moſt horizontal is to the other, as three to one.

The traces of the horſe hindmoſt but one being long, will incommode the hindmoſt horſe in turning, if they have nothing to ſupport them. To prevent this, two links muſt be fixed to the ſhoulders of the hindmoſt horſe, and the traces paſſed through them; the links long enough to allow the traces to be ſtretched.

When two horſes are ſufficient for the draught, the yoking them in this manner deſcribed for the two hindmoſt, removes alſo the ſecond inconvenience mentioned, that attends the yoking the cattle in a line: for the ploughman diſcerns, by the going of the plough, when any of them neglect their work, in the ſame manner as when there are four horſes in the plough yoked in pairs.

The ordinary method of yoking oxen, is attended not only with all the inconveniencies of yoking cattle in pairs, but alſo with the laſt-mentioned inconveniency, of yoking cattle in a line. For the ſoam, by which the foremoſt cattle draw, is fixed to the yoke of the hindmoſt pair. Their yoke being higher than the beam, a great weight is laid upon their necks by the drawing of the foremoſt cattle. This inconveniency may be removed, and the oxen yoked in ſuch a manner, as to give two directions to the plough, as is done when horſes are yoked in pairs; by which the draught will likewiſe be made ſtronger. To do this, the ſoam of the pair immediately before the hindmoſt muſt be fixed, not to their yoke, but to the beam; and, to prevent this ſoam from incommoding the hindmoſt in turning, a link muſt be fixed to their yoke for it to paſs through, the link long enough to allow the ſoam to be fully ſtretched. X When there are more than two pair in the plough, as is moſt common, the largeſt-ſized cattle ſhould be placed next the plough, and the ſmalleſt-ſized immediately before them. For the lower that the yoke of theſe laſt is placed, the nearer will the direction of their ſoam be to the ſoam of thoſe before them; and thereby the leſs weight laid upon their necks. This method of placing the cattle is contrary to the ordinary way: for it may be obſerved, that the ſmalleſt-ſized oxen are always placed next to the plough. But theſe different ways of placing the cattle are both founded upon the ſame reaſon: For the ſmalleſt-ſized oxen are placed next the plough in the ordinary way of yoking, that ſo their yoke, to which the ſoam of the pair before them is fixed, may be as low as poſſible: for the lower that it is placed, the nearer the directions of the two ſoams approach each other, and the leſs weight is laid upon the necks of the hindmoſt pair. And, for the ſame reaſon, the loweſt-ſized oxen ſhould be placed in the middle, when yoked in the manner propoſed, that ſo they may be leſs incommoded by the pair before them.

If, in conſidering the moſt proper method of yoking cattle in ploughs, we had nothing in view but the ſtrength of the draught, and conveniency of the cattle;

we would always recommend the yoking the cattle in ſuch a way, as to apply two forces to the plough in different directions. But as we muſt alſo have in our view the going of the plough, hence it becomes neceſſary to obſerve, that ſometimes it is an advantage, to have the draught of the whole cattle in the ſame direction.

In ploughing lea, where the ſward is tough, or any kind of land, where there are interruptions from roots, or the hardneſs of the bottom; the plough, if two forces are applied to it in different directions, goes very unſteadily, ſometimes too deep, and at other times too ſhallow; and is very difficult to manage. The reaſon is obvious: When the plough meets with ſuch interruptions, as tend to make it go deeper, or ſhallower, than its ordinary way of going; if, at the ſame time, the force that acts contrary to the interruption ceaſes; then the plough, in ſpite of all the attention of the ploughman, will either ſtart out of ground, or go in too deep, according to the tendency of the interruption. But when there is only one force acting upon the plough, it is, in ſome reſpect, like the wheeled plough; it goes ſteadily, and at a certain depth; at leaſt, it is not ſo difficult to manage it, as when there are two forces acting in different directions: For though ſome of the cattle, at the time when the interruption is given, ſhould ceaſe to draw, yet the draught continues ſtill in the ſame direction, and the ploughman has only the alteration occaſioned by the interruption, to rectify. Every perſon knows, that an ox-plough goes much more ſteadily than a horſe-plough: and this is occaſioned, not only by the nature of the animals, oxen being more ſteady in drawing than horſes; but alſo by the manner of yoking them, oxen being yoked in ſuch a manner, as that one force only is applied to the plough.

Thus it appears, that no abſolute determination can be given, which of theſe two ways of yoking cattle in ploughs is to be preferred. Men muſt weigh the advantages and diſadvantages attending each way, and determine according to circumſtances. If the land is of a kind not eaſily ploughed, the cattle not well trained, and the ploughmen not expert, the work will be beſt performed, if there is only one force applied to the plough *. But if the land is eaſily ploughed, that is, has few things in it to incommode the plough in going; if the cattle are well trained, and the ploughmen expert, the work will be well enough performed, and the labour leſs ſevere upon the cattle, if two forces are applied to the plough in different directions.

CHAP. XIII.

Of ploughing.

THE action of the plough, in ſtirring and turning over the ſoil, is called *ploughing*. Ploughing then ſerves the following purpoſes. It increaſes the food of plants, enlarges their paſture, prepares the vegetable food for entering their roots, deſtroys weeds, and removes wetneſs.

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* WHEN there are four horſes in the plough in pairs, they are commonly yoked in ſuch a manner, as to apply two forces to the plough in different directions. If it is found proper to apply but one force to the plough, and keep the horſes yoked in pairs, the firſt pair muſt be yoked to the laſt.

Ploughing increaſes the food of plants, by opening the ſoil to receive the vegetable food from the air; and by enlarging the ſurface, and thereby expoſing a greater quantity of the ſoil to its influence *.

Ploughing enlarges the paſture of plants, by opening the ſoil, if too ſolid, and making it firm, if too light †.

Ploughing prepares the vegetable food for entering the roots of plants, by reducing vegetables to a ſtate of corruption, and diſſolving oils ‡.

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laſt, in the ſame manner as the two laſt horſes are commonly yoked to each other, when there are three or four yoked in a line.

* See book 1. chap. 4. † See book 1. chap. 6.

‡ See book 1. chap. 7.

PLOUGHING deſtroys weeds, by making their ſeeds vegetate, and then tearing up the young plants; and by expoſing their roots to the drought *.

PLOUGHING removes wetneſs, by laying up land in proper ridges †.

IT may be ſaid, therefore, that ploughing is one of the moſt important operations in agriculture; and that the greateſt care is to be taken in the performance of it.

THOUGH ploughing in general ſerves all the purpoſes mentioned, yet commonly one of them only is chiefly in view; and according to the deſign in view the work is to be performed.

WHEN the deſign of ploughing is to increaſe the food of plants, the ſurface cannot be made too uneven; for the more uneven that the ſurface is made, the greater quantity of the ſoil is expoſed to the influence

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* See book 1. chap. 12. and 13. † See book 1. chap. 15.

fluence of the air, and the greater quantity of food procured *.

WHEN the deſign of ploughing is to enlarge the paſture of plants, that kind is beſt that goes deepeſt, (provided the ſoil allows), and moſt effectually breaks the mold; for the deeper that the plough goes, the greater quantity of ſoil is employed in vegetation; and the more effectually that the mold is broken, the larger is the paſture in the ſame quantity †.

WHEN the deſign of ploughing is to deſtroy root-weeds, the ſurface cannot be left too rough, nor the earth of the furrow raiſed in too large pieces; for the rougher that the ſurface is, and the larger the pieces of earth raiſed, the drought has the eaſier acceſs, and more effectually operates in the deſtruction of the roots.

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[*] THE increaſing of the food of plants is often the chief deſign of fallowing, and of giving the barley-land the winter and ſpring ploughing.

[†] THE enlarging the paſture of plants is the chief deſign of ploughing, when ſeed is to be ſown immediately after.

WHEN the deſign of ploughing is to deſtroy ſeed-weeds, the ſurface cannot be made too ſmooth, nor the mold too much broken: for the ſmoother that the ſurface is made, and more effectually that the mold is broken, the ſeeds are the more expoſed to the influence of the air, the ſap better preſerved, and their vegetation the more encouraged *.

WHEN the deſign of ploughing is to remove wetneſs, the land muſt be laid up in high and narrow ridges; for the greater number that there are of furrows, there are the greater number of drains; and the higher that the ridges are, the more eaſily the water finds its way to the furrows †.

THUS we ſee how this operation of ploughing is to be performed, according to the chief deſign in view. It often happens, however, that land is in ſuch a condi-

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* THE deſtruction of weeds of both kinds is often the end propoſed in ſummer-fallowing, and when the barley-land gets the ſpring-furrow.

† SEE next chapter.

tion as to require more than one of theſe advantages which ploughing is intended to promote. Theſe are ſometimes conſiſtent with each other, and the land may be ploughed in ſuch a manner as beſt to promote all of them. Thus land is ſometimes, at the ſame time, poor, and wet, and full of root-weeds: now, it may be ploughed in ſuch a manner as is moſt proper for increaſing its food, removing its wetneſs, and deſtroying its weeds: for, by one ploughing, its ſurface may be made uneven, which fits it for receiving an increaſe of food; it may be formed into narrow and ſteep ridges, which beſt removes its wetneſs; and the earth may be raiſed in large pieces, which beſt expoſes the roots of the weeds to be deſtroyed by the drought.

At other times the land is in ſuch a ſituation, that the advantages which it requires from ploughing are inconſiſtent with each other, and it cannot be ploughed in ſuch a manner as is moſt proper for promoting all of them. Thus land, at the ſame time, may be full both of ſeed-weeds and of root-weeds: now, it cannot be ploughed in ſuch a manner as is moſt proper to deſtroy both; for by one ploughing it cannot be raiſed in pieces and left rough, which is neceſſary to deſtroy root-weeds, and have the mold broke and be made ſmooth, which is neceſſary to deſtroy ſeed-weeds. This makes it neceſſary to have one of theſe things chiefly in view at firſt, and to conſider which of the two it is proper to begin with, and how the work may be performed in ſuch a manner, as the other may moſt eaſily ſucceed. Thus, in the preſent caſe, the land ſhould be ploughed, ſo as to be raiſed in pieces, and to be left rough; and in that condition it ſhould be allowed to lie, till the drought may be ſuppoſed to have deſtroyed the roots; and then it may be reduced, the pieces broke, and the ſurface made ſmooth, in order to deſtroy the ſeeds.

IN ploughing there are ſome general rules to be obſerved, whatever is the deſign of it. Thus land is never to be ploughed when it is wet. When land is ploughed wet, the deſign of ploughing, whatever it may be, is fruſtrated; and this holds true in every kind of ſoil.

WHEN ſtiff ſoil is ploughed wet, by drying too ſuddenly it becomes ſo hard, that it can receive no benefit from the air, and the paſture in it is entirely ſhut up: root-weeds ſtrike root again before the drought reaches them; and if there are any ſeed-weeds, the ſurface cruſts ſo ſoon, that they are prevented from vegetating.

WHEN light ſoil is ploughed wet, though it may receive ſome benefit by expoſing a larger ſurface to the influence of the air, yet its pores, being full of water, will prevent its paſture from being enlarged; and the root-weeds that are in it, will not be deſtroyed; they will rather flouriſh, by being tranſplanted into a new paſture *. In both kinds of ſoil the labour

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* BY light ſoil is here to be underſtood not ſandy, but ſpungy moſſy ſoil. The ſandy ſoil is in its nature ſo free, and, at the ſame time, ſo compact, that little alteration can be made in its paſture by ploughing.

is very ſevere upon the cattle, and the land is greatly damaged by their going upon it, and treading it down with their feet.

THUS it is alſo to be obſerved, that whatever is the deſign of ploughing, the quantity of firm land taken off from the ſurface by the plough in going, ought not to exceed the wideneſs of the furrow which the plough makes below. If it does, the land is not clean ploughed; it is only ſcratched, and a quantity of the ſoil is left below untouched betwixt every furrow that the plough makes.

THE quantity of firm land to be taken off by the plough, depends upon the deſign of ploughing, and the nature of the ſoil.

WHEN the deſign of ploughing is to increaſe the food of plants, and deſtroy root-weeds, whether the ſoil is ſtiff or light, as great a quantity may be taken off as the plough can take conveniently; becauſe the greater that the quantity is which the plough takes off, the rougher and more uneven the ſurface is made; and the rougher and more uneven that the ſurface is made, the more food is procured, and the root-weeds more effectually deſtroyed.

When the deſign of ploughing is to enlarge the paſture of plants, and deſtroy ſeed-weeds, though a large quantity may be taken off in light ſoil, that naturally falls in pieces when turned over, yet a ſmall quantity ought to be taken off in ſtiff land that is not ſo eaſily reduced; becauſe the ſmaller that the quantity is which the plough takes off, the ſoil is the more effectually broken, and the ſurface made the ſmoother; and the more effectually that the mold is broken, and the ſmoother that the ſurface is made, the paſture is the more enlarged, and the weeds more effectually deſtroyed. This is agreeable to the ordinary practice, introduced no doubt from experience; for we find that a much leſs quantity is taken off when land gets the ſeed-furrow, the chief deſign of which is to enlarge the paſture, than at any other ploughing.

IN the directions which we have given about ploughing, we have had chiefly in our view land employed in tillage; it is neceſſary to add ſomething with reſpect to the ploughing lea, or opening up graſs-ground.

THE Engliſh writers on agriculture, when giving directions about the opening up of graſs-ground, always ſuppoſe that the land is to be ſummer-fallowed; and they recommend to plough as deep at firſt as the nature of the ſoil will allow. They aſſign this reaſon, That it is not poſſible to plough deeper afterwards. They likewiſe direct to turn the earth upſide down, or on its back, as we have called it. The reaſon they aſſign for this, is, that the ſward or turf may be the ſooner rotten *.

SOME perſons have tried this method of breaking up graſs-ground in Scotland, but they found great difficulty in reducing it: and,

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* THIS however is not the ordinary method uſed in England; as in Scotland they plough ſhallow and narrow in winter, and ſow oats in the ſpring.

and, notwithſtanding the aſſertions of ſome of the Engliſh writers, we have reaſon to believe that many find it ſo likewiſe in England; for Mr Tull, in his chapter upon ploughs, tells us, That if the turf lie long without being turned, the graſs from the edges will ſpread and form a new turf, and that the roots often ſet up new heads, and the former heads are converted to roots. As Mr Tull's deſign is to ſhow the neceſſity of the four-coultered plough, we need not doubt but he has a little exaggerated the matter; for, upon a narrow inſpection, it will be found, that if turf is turned upon its back, the graſs will grow only from the ſides. However, we may conclude, from what he ſays, that the land in England is not ſo eaſily reduced in this manner, as ſome of the writers pretend *.

On

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* The author of the new ſyſtem of agriculture, in giving directions about the method of breaking up graſs-ground, mentions only three ploughings before ſowing with wheat, whether in ſtiff or light land. He propoſes, that the firſt ploughing ſhould be begun about the firſt of April, and ended about the middle of June; and that the ſecond ſhould be begun about the middle of June, and finiſhed about the end

of

On our rich lands in Scotland, we follow a method the very reverſe of this which has been mentioned. We commonly ſow after one ploughing of graſs-ground, and we plough as ſhallow and narrow as poſſible; and alſo ſet the turf as exactly as poſſible upon its edge. It is not our buſineſs in this place to conſider the propriety of ſowing after one furrow. We may only obſerve, that if the land is good, a good crop may be expected; and if there is a good crop, the turf will be completely rotten before next ſeaſon. What we have to conſider, is, which is the moſt proper method to break and reduce the turf. May I be allowed to ſay, without giving offence to improvers, that the Scots method is rather the beſt? It is certain, that the thinner and narrower that the turf is taken off, it is the more eaſily torn aſunder; and the more exactly that it ſtands on its edge, the harrows in going acroſs

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of July. If the ſecond ploughing is begun on the ſame part of the field where the firſt ploughing was begun, the turf, he ſays, will be found ſufficiently rotten when it is turned up again.

take the firmer hold, and make the greater impreſſion.

If this kind of graſs-ground is ploughed before winter in the manner mentioned, ſhallow and narrow, and the turf ſet upon its edge, it may be expected, if we are favoured with a little froſt, that in the ſpring the turf will be in ſuch a condition, as to be eaſily torn aſunder by the harrows, and the land itſelf in a proper condition to be ſown with oats, or to be ſummer-fallowed, and ſown with wheat.

Our barren lands we break up in the ſame manner as recommended by the Engliſh writers, plough deep, and turn the turf over on its back. It ſeems, that the plants which grow on theſe lands, have tougher and ſtronger roots than thoſe that grow on rich lands. This makes it more difficult to break the turf. If the earths of the furrows are ſet on their edge, the harrows turn them back, inſtead of tearing them aſunder. This happens whether the land is ploughed deep or ſhallow.

But when the earths are turned on their back, and the land ploughed deep, the harrows raiſe a kind of mold upon the back of the turf, by which the hollows betwixt the earths are filled up, and nouriſhment afforded for the ſeed, the greateſt part of which falls into theſe hollows.

THERE is another method propoſed for opening up graſs-ground, and that is by trench-ploughing. This manner of ploughing is performed by one plough following another in the ſame track. The plough that goes firſt, turns over the ſward or turf; and the one that follows, turns up ſome inches of ſoil upon it. By this method there is ſufficient nouriſhment provided for the crop, and the ſward is rotten before next ſeaſon *.

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* The plough that goes firſt ſhould have a feathered ſoke, if the land will allow it, and the mold-board ſhould be ca far outwards above, where it is fixed to the leſſer handle. Fo this kind of ſoke is moſt proper for raiſing the ſward; an this kind of mold-board for turning it upon its back. is neceſſary to add, that where the ſoil is ſhallow, the tu ſhould be taken off as thin as poſſible.

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This kind of ploughing needs not be confined to the opening up of graſs-ground; it may be uſed in any ſoil that is deep; for by it ſome new ſoil is turned up, and a greater quantity employed in vegetation.

CHAP. XIV.

Of ridges.

It has already been obſerved, that ploughing in ridges is proper for removing wetneſs. Every furrow becomes a kind of drain: the rain that falls upon the ridge, makes its way to the furrows, and by means of them is conveyed away from the field[*].

Ploughing in ridges is alſo proper for enlarging the ſurface. It is certainly an advantage to have the ſurface enlarged. Thereby not only a greater quantity of ſoil is expoſed to the influence of the air, but alſo a greater quantity of it actually employed in vegetation. There is no more ſoil added to the field by enlarging the ſurface; but ſome of the ſoil that lies buried, while a field is in its natural ſtate, is expoſed to the air, and brought within reach of the roots of plants, when it is laid up in ridges. Some of the plants which we cultivate in our fields, have what are called horizontal roots, that is, roots that creep along the ſurface, and go down but a ſhort way. Now, it is obviouſly an advantage to theſe plants, to have a quantity of the ſoil below, to which their roots cannot extend, brought within their reach, which is done by enlarging the ſurface.

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[*] See book 1. chap. 15.

THE top-rooted plants, that is, ſuch as puſh one principal root perpendicularly downwards, have alſo horizontal roots, by which they are nouriſhed; and therefore it muſt likewiſe be an advantage to them, to have the ſurface enlarged.

To illuſtrate this further, let us ſuppoſe, that the roots of plants upon a field extend themſelves through the whole ſoil within four inches of the ſurface. Now, it is obvious, that there is more ſoil within four inches of the ſurface, when the ſurface is enlarged by ridges, than when the land is lying quite flat.

From theſe things then it appears, that a field contains more food, and has a larger paſture when in ridges, than when laid down level.

It muſt be acknowledged, that ſome conſiderable perſons are of a different opinion; and as this is the caſe, it will not be improper to conſider what is advanced by them.

There are ſome who mention the perpendicular growth of plants, as an evidence, that a ſurface, however much extended, can ſupport no more plants than the horizontal baſe. Though the fact is allowed, that plants grow perpendicularly, and that it is impoſſible to place more of them upon the ſurface than upon the baſe; yet it does not follow, that a field, when its ſurface is enlarged, can nouriſh no more of them: and it is to be remembered, that it is not more room which we contend for, but more nouriſhment. We may further obſerve, with reſpect to the growing of vegetables, that the enlarging the ſurface has this other advantage; it gives the plants more air, and thereby prevents them from falling down and lodging.

Mr du Hamel, to ſhow that the enlarging the ſurface by ridges is a real diſadvantage, obſerves, that ſuppoſing the ſlope in ridges is one foot in ſix, yet the ſurface will be to the horizontal baſe only as 76 to 75, which, he ſays, is but a ſmall advantage, when compared to the loſs by the furrows.

In anſwer to this, it needs only be ſaid, that there is no loſs by the furrows, unleſs when they are a real advantage to the reſt of the field. When land is dry, the corn is as good in the furrows as in any part of the ridge; and when the land is wet, the furrows ſerve for drains, and the loſs by them is more than made up by the advantage which the reſt of the field receives by being drained.

We may therefore conclude in the general, that the way of ploughing in ridges is preferable to the way of ploughing without ridges *.

Having ſhown, that ridges are advantageous as they remove wetneſs, and enlarge the ſurface, it is neceſſary now to conſider what kind of ridges are moſt proper for anſwering the ends propoſed.

As ridges remove wetneſs, when the

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* It is a cuſtom in ſome places, to plough without making ridges. It is done in this manner: The plough enters in the outſide of the field, and goes round and round it till it is near finiſhed, and then ploughs out what remains in the ſame manner, as if it was a ridge. Thus the field is left without ridges, having only one furrow for a ſhort way in the middle of it. At the next ploughing this may be reverſed, the ridge in the middle of the field gathered up, and the plough go round and round the ridge till the whole field is ploughed.

ſoil is wet, the ridges ought to be narrow. For the greater number that there are of ridges, there are the greater number of drains. When the ſoil is wet, the ridges ought alſo to be ſteep. For the ſteeper that the ridges are, the water more eaſily finds its way to the furrows.

WHEN the ſoil is very dry, it is ſubmitted, if narrow ridges are not proper likewiſe. For by altering the ridges, and turning the furrows into the crowns, and the crowns into the furrows, a quantity of freſh ſoil is always employed in vegetation. When the crown of a ridge is turned into a furrow, it is obvious that ſome freſh ſoil is turned up, which was not employed in vegetation in its former ſituation; and the greater number there are of ridges, there is the greater quantity of freſh ſoil employed.

WHEN the ſoil is juſt ſo wet as to occaſion loſs in the furrows, then the ridges ſhould be ſomewhat broader. For, in this caſe, the fewer there are of furrows, there is the leſs loſs.

It is proper to obſerve here, that a difference ſhould be made betwixt the ſituation of land in the winter, and its ſituation in the ſummer. It may be convenient ſometimes, when winter-grain is to be ſown, or when the land is to get winter-fallowing, to make the ridges very narrow; and, when ſummer-grain is to be ſown, to make them broader.

As it is an advantage to have the ſurface enlarged, the ridges ought to be made high in the middle, or crown. For the higher that the ridge is made, the more is the ſurface enlarged.

When the ſoil is ſhallow, the ridges, if broad, cannot be high raiſed, without depriving the furrows of ſoil: and therefore, to enlarge the ſurface on ſuch land, the ridges muſt be made narrow. For this both enlarges the ſurface, and prevents

vents the furrows from going below the ſoil.

WHEN the ſoil is deep, the ridges may be made broader: for though the ridges are raiſed in the crown, yet ſtill there is ſoil left in the furrows. But then the ridges muſt not be made too broad: for it is evident, that narrow ridges give more ſurface than broad ridges, of the ſame degree of ſteepneſs; and do not cover the lower parts of the ridges ſo much from the influence of the ſun and winds.

IT is neceſſary to obſerve, that though, in the general, it is recommended to raiſe the ridges in the crown, to enlarge the ſurface, and to allow the water more eaſily to find its way to the furrows; yet, in ſome low flat-lying land, it is proper to make the ridges as flat as poſſible, in order to raiſe the furrows. For the higher that the furrows are raiſed, there is, in ſome caſes, the greater command of the water, and it is the more eaſy to find a fall for conveying it away.

It is neceſſary to obſerve likewiſe, that flat ridges have this advantage over ſteep ridges; they can be ſown with greater exactneſs. It is obvious from the method of ſowing, that, in ſowing ſteep ridges, it is not poſſible to prevent too great a proportion of the ſeed from falling into the furrows. It is obvious likewiſe, that this proportion is increaſed by harrowing. Whereas, in ſowing flat ridges, the ſeed is equally ſcattered, and the harrows do not remove it from its place.

From theſe obſervations it is obvious, that ſoils in different ſituations require to be laid out in different kinds of ridges. It is abſurd, therefore, to aſſert, that, in every caſe, one kind of ridges is preferable to another; that narrow ridges are better than broad ridges, and flat ridges better than ſteep ridges. In ſome ſituations, one kind of ridges is moſt proper; and, in other ſituations, another kind is moſt proper. Every perſon ought, therefore, to conſider the nature of the ſoil he has to deal with, conſider the advantages and diſadvantages of each kind of ridges, and then determine which are moſt proper.

When there is nothing in the nature of the ſoil to determine what kind of ridges are moſt proper, then narrow ridges are to be preferred; for this reaſon, that a quantity of land in narrow ridges is ſooner ploughed than when in broad. It is obvious, that the two firſt furrows which the plough takes off from the ridge, are wider than any taken off afterwards, eſpecially if the plough begins in the furrow, as is frequently the caſe; ſo that the greater number there are of ridges, the field is the ſooner ploughed. Beſides, when ridges are broad, it is obvious, that the plough has more work, and muſt take longer time in turning, than when they are narrow. But then it is ſuppoſed that the ridges are ſtraight and equal. If they are not, the greater number there are of them, the greater is the trouble, and the more time is ſpent in ploughing. This, however, it muſt be owned, is of no great importance; becauſe it ſeldom happens, that the kind of ſoil does not determine what kind of ridges are moſt proper.

Having conſidered the kinds of ridges proper for land, according to its different ſituations; it is proper to inquire, whether there are any qualities which ridges ought to have, whatever is the ſituation of the land.

It will eaſily appear, that all ridges ought to be made ſtraight. Crooked ridges, it is obvious, are attended with ſeveral inconveniencies. In ploughing them, the cattle are not always going exactly in the ſame direction with the plough; ſhort turnings are often neceſſary, as fields are generally bounded by ſtraight lines, or lines not crooked in the ſame manner with the ridges; and, when there is a ſmall deſcent, the water, as it runs in the furrows, meets with reſiſtance.

It is obvious, that when the plough goes in a curve, as it does in ploughing crooked ridges, the draught is not in the ſame direction with the beam, but is either to the right or left of it; and this gives the plough either too much or too little land.

It is obvious likewiſe, that, when ridges are crooked in a manner different from the lines by which a field is bounded, in ploughing the ridges upon the ſides, one part of them muſt be finiſhed before ſome other parts are near done; and thus ſhort turnings are neceſſary, which hurt the land much by the treading of the horſes.

It is obvious likewiſe, that, as a crooked furrow is continually altering the direction of the water, and has a leſs deſcent than a ſtraight furrow, the water, as it runs along it, muſt meet with greater reſiſtance, and thus penetrates the ſoil, and makes it more difficult to convey it away.

THESE inconveniencies are removed by making the ridges ſtraight. For, in ploughing ſtraight ridges, the cattle are always going in the ſame direction with the plough; no ſhort turnings are neceſſary, as fields can be made of an equal breadth in all places; and the furrows having a greater deſcent, the water meets with leſs reſiſtance, and is more eaſily conveyed away.

STRAIGHT ridges not only remove the inconveniencies with which crooked ridges are attended, but it is found that they are attended with no inconveniencies themſelves: they require indeed a little attention in the ploughman, which is itſelf an advantage; and therefore, upon all occaſions, are to be preferred.

As, in all kinds of ſoil, ridges ought to be ſtraight, ſo likewiſe they ought to be equal, equal one to another, and the ſame ridge equally broad in all places. Unequal ridges are attended with inconveniencies, as well as crooked ridges. It is difficult to ſow them with exactneſs; it is difficult to alter them, when neceſſary; and the plough muſt often turn in the middle of the ridge, which does great harm, by the treading of the horſes, or it muſt be driven empty to the end.

THESE inconveniencies may be removed by making the ridges equal. Equal ridges may be ſown with greater exactneſs, and conſequently with leſs ſeed; it is eaſy to change them, one into two, or two into three, as occaſion requires; and the ſame furrow that finiſhes the ploughing of the ridge in one place, finiſhes it in all places; ſo that there is no neceſſity to turn the plough in the middle of the ridge, or to drive it forward the ſhorteſt ſpace, without turning up a furrow.

CHAP. XV.

Of altering ridges.

IN the laſt chapter, we endeavoured to ſhow what kind of ridges are moſt proper for the different ſoils; and what qualities they ſhould be poſſeſſed of in all ſoils.

In many places of the kingdom, they are ſtill crooked and unequal; and, in many places, they are much broader, and much higher raiſed in the crown, than the nature of the ſoil allows. Were the ridges altered, and the fields laid down in a proper manner, as the ſoil requires, it would be a great advantage. At the ſame time, it may be obſerved, that much harm is done, by proceeding in this matter with too much precipitancy. It is neceſſary, therefore, that we conſider it as an affair of ſome importance.

It is neceſſary to obſerve, in the firſt place, that ridges muſt not be raſhly altered; on the contrary, great caution is to be uſed.

If the ſoil is very dry, ridges may be altered without great danger, though high; and they may be made ſtraight without being levelled. For, though the old furrows are ſtill lower than the reſt of the field, yet this is attended with no bad conſequences in dry land; and, by degrees, they are filled up in ploughing But then, it is to be obſerved, that there is not much land in Scotland, on which the ridges, at preſent, are high raiſed, in its nature ſo dry, as to allow this to be done.

IF the ſoil is wet, the ridges cannot be made ſtraight till the ground is level, without great danger. For the water will lodge in the hollows of the old furrows, from whence it will not be poſſible to force it. Some perſons that make their ridges ſtraight before they are ſufficiently levelled, draw water-furrows along the hollows of the old furrows, to carry off the water that is apt to lodge there. This is of ſome uſe, but does not fully anſwer the purpoſe. A quantity of looſe earth, in ploughing, is thrown into the old furrows. The water, as it falls, penetrates this looſe earth, and is retained by it, notwithſtanding the water-furrows. Beſides, theſe water-furrows muſt be neatly cleaned out with a ſpade, and made deeper in the places where they are intercepted by the crowns, of the new ridges, otherwiſe they are of very little uſe.

BEFORE ridges can properly be made ſtraight, it is neceſſary therefore that the land be made as level as poſſible.

BUT it muſt be obſerved, that it is as dangerous to level ridges raſhly as to alter them before they are levelled: for if ridges are levelled too faſt, and thereby a great depth of looſe earth thrown ſuddenly into the furrows, it will not be poſſible to convey away the water that falls upon them. The water as it falls will ſink to the bottom, and there will lodge and chill the ſoil; and the earth thrown into the furrows being looſe, the cattle in ploughing muſt ſink to the bottom likewiſe, by which the land is very much potched.

IT is recommended therefore to every perſon, ſeriouſly to conſider the nature of the ſoil he has to deal with, before he proceeds to the altering old ridges; and if the ſoil is wet, to level the ridges very gradually. When the ſoil is deep, and inclining to be wet, and a ſufficient ſlope for carrying off the water, it is probable, that the loſs ariſing from the levelling ſteep and broad ridges ſuddenly, may exceed the profit of many years ariſing from the ridges being properly laid down; and therefore, if a view to incloſing makes it neceſſary to ſtraight the ridges, the levelling them ſhould be the work of ſeveral years. Even ſuppoſing that the ſoil is ſhallow, and the ridges raiſed ſo high, that there is nothing but *till* left in the furrows, yet ſtill it is improper to level the ridges too faſt, though levelling in this caſe is neceſſary*.

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* When ſoil is of a cold ſpungy nature, and does not eaſily part with the water, unleſs there is a ſcheme of improving it by lime or marles, it is uncertain whether it may not be proper to continue the ridges broad and high, though the furrows are deprived of ſoil. The levelling the ridges in this caſe makes the whole ſoil in danger of being chilled, as the water is not ſo eaſily conveyed away; whereas, when the crowns of the ridges are high above the furrows, the water

more

In levelling ridges a great hollow is made in the crowns. This is occaſioned by frequent ſucceſſive cleavings, which is the method commonly uſed for levelling ridges. It is obvious, that by the firſt cleaving a hollow is made in the crown of the ridge equal to the depth and breadth of the furrow which the plough makes; whereas the parts on each ſide of the ridge are but little levelled, and at each ſucceſſive cleaving this hollow is made greater. Such a quantity of new earth immediately turned up, is not fit for vegetation *. Beſides, this hollow becomes ſo great, and the parts of the ridge on each ſide of it become ſo ſteep, that it is impoſſible to plough them in a proper manner.

In this caſe, when levelling is ſtill

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more eaſily finds its way to them, and thereby a part of the land is preſerved in proper order; which may poſſibly do more than overbalance the loſs of ſoil ariſing from the lowneſs of the furrows.

* As it is probable that the earth receives its vegetable food from the air; ſoil, though in its nature fit for receiving this vegetable food, when new turned up from below the reach of the air, is not fit for nouriſhing plants.

thought proper, ſome furrows from each ſide muſt be thrown back by the plough into this hollow, by which a new ſmall ridge is formed upon the crown of the old one, and then the remaining parts of the ridge may be levelled as before. Some perſons, inſtead of this, plough acroſs the ridges. This method ſerves the ſame purpoſes; it both throws ſome earth into the hollows, and levels the ridges: for the plough in going carries off ſome earth from every height, and leaves ſome in every hollow. But then land muſt not be left in this ſituation during the wet ſeaſon, unleſs water-furrows are drawn along the furrows, and alſo in ſome caſes along the crowns; for unleſs this is done, the water that falls upon the field cannot be conveyed away. At the next ploughing, the whole old ridges may be levelled in the ſame manner as at the firſt ploughing; or, if thought more proper, may be divided into two equal ridges, ploughed in ſuch a manner that the furrow betwixt them may be exactly in the crown of the old ridge, and the other furrows exactly in the furrows of the old ridge. By this operation the old ridge is raiſed from the furrows, and levelled from the crown *.

When a perſon is upon a ſcheme of levelling, this method of dividing the ridges into two will be found very proper, either when winter-grain is to be ſown, or when the barley-land gets the winter-ploughing.

Though land may be in ſuch a ſituation as to allow the ridges to be levelled with ſafety, yet unleſs it is remarkably dry, and in no caſe in danger of being damaged by too much water, the ridges ſhould not be altered, excepting when the land is ſummer-fallowed; and in that caſe, beſides the ploughing that alters the ridges, there ought to be another before the wet ſeaſon comes on, that ſo the bottom may be ſufficiently firm to reſiſt the water.

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* This method of dividing the ridges into two is very proper, whether immediately before this they have been ploughed acroſs, or a ſmall ridge formed upon the crown of the old one in the manner that has been deſcribed.

CHAP. XVI.

Of the poſition of ridges.

WE have obſerved, that ridges ſerve to remove wetneſs, and to expoſe the ſoil to the influence of the air, and we have ſhown what kind is moſt proper for theſe purpoſes. But this is not enough; it is neceſſary likewiſe to conſider in what manner ridges ought to be placed. This is a matter of ſome conſequence: for, according to the poſition of ridges, water may be either conveyed away or retained; and ſome aſſert likewiſe, that by this the ſoil may be better expoſed to the influence of the ſun and wind. Theſe things therefore muſt be kept in view in the placing of ridges.

WHEN the land is wet, as is often the caſe, it is certain that ridges ought to be placed with a view to the conveying away the water: but when land is dry, as is ſometimes the caſe, then ridges ſhould be placed with a view to the retaining the water.

The moſt common way of placing ridges where there is a ſlope, is along the declivity in a ſtraight line from the top to the bottom; and land is commonly laid out with a view to this. Where the declivity is gentle, this is, no doubt, a very proper way of placing the ridges; but if the declivity is great, this way of placing the ridges allows the ſoil to be waſhed away by the rain. It is obvious, that water, in running off of land, carries a part of the ſoil along with it, and the quantity is great, in proportion to the violence with which it runs. In climates where there are heavy ſhowers of rain, the damage done by this is not inconſiderable. Therefore, in this caſe, placing ridges acroſs the declivity is the moſt proper way; for when ridges are placed acroſs, the water meets with many interruptions in its courſe, and does not run off with ſuch violence as when placed along from top to bottom, and therefore does not carry off ſuch a quantity of the ſoil along with it.

Instead of this ſome perſons make the ridges very narrow. This ſerves the ſame purpoſe; for in proportion to the number of furrows, there is the leſs water in each furrow, and conſequently it runs with leſs violence. However, placing the ridges in this manner is not ſo proper for this purpoſe as placing them acroſs the declivity, and, beſides, is not ſo proper for retaining the water in a dry ſeaſon.

When land is very dry, and in no danger of being damaged by the ſtagnation of water, the ridges ought to be placed acroſs the declivity, as near the level as poſſible; for this retains both the water and the ſoil. It is obvious, that when ridges are placed in this manner, the water cannot get off by running along the ſurface, by which the ſoil is in greateſt danger of being carried away. As the furrows ſtop it in its courſe down the hill, it can get off in no other way than by penetrating the ſoil. By this a part of it is retained; what of it gets off is clear, and carries no ſoil along with it.

When land is dry at the head of the ridges, and wet at the foot, and no proper fall for carrying off the water, as is frequently the caſe, the ridges ſhould be placed in the ſame manner, directly acroſs the declivity. For, in this caſe, every furrow in ſome meaſure retains the water that falls upon the ridge above, and thereby prevents it from ſinking towards the bottom of the field, and lodging there. By this way of placing the ridges, the dry part of the field is rendered wetter, and the wet part of the field is rendered drier than otherwiſe they would be.

This is likewiſe a very proper way of placing the ridges, even when the declivity is but ſmall, if the land is in the ſituation mentioned, dry at the head, and wet at the foot. It muſt be owned, however, that this will not entirely anſwer the end propoſed: for the water will penetrate the ſoil; and when it is reſiſted by till or clay, will find its way along theſe to the bottom of the field. But this will not be ſo ſudden, as in the other way of placing the ridges; and the ſoil at the head, which is naturally dry, will receive more benefit from the rain as it falls.

WHEN land is wet, and the water may be conveyed away from the bottom of the field, the ridges ſhould be placed acroſs likewiſe; not directly, but with a ſmall ſlope to a drain or furrow on the ſide of the field from top to bottom, by which the whole water is conveyed away. In this caſe every furrow becomes a drain to the ridge below, and prevents the water from running over it.

WHEN land is wet from the breaking out of ſmall ſprings, this way of placing the ridges is alſo very proper. The furrows convey away the water as it riſes, and prevent it from doing any damage.

IT is neceſſary to obſerve, that ridges

placed in this manner, to ſerve theſe purpoſes, ſhould not be altered; for when the furrow is kept in one place, it is a more proper drain than when altered. When the furrows are kept in one place, the bottom is always firm, and the water runs eaſily along it; whereas, if changed, it may fall upon places of the field, where the ſurface, being raiſed by former ploughings, will prevent them from reaching the firm bottom. Beſides, if the ſprings break out in the furrows, by changing their place, they may break out in other parts of the ridge.

It is neceſſary to obſerve likewiſe, that ridges placed in this manner ſhould not be raiſed in the crown, but kept quite flat; that ſo, by the natural deſcent of the ground, the whole water that falls upon the ridge may be conveyed into the furrow below.

It was before obſerved, that ſome perſons aſſert, that, by a proper poſition of ridges, the ſoil is better expoſed to the influence of the ſun and air. Theſe perſons recommend the paying a regard to this. But it cannot be done excepting when the land is quite flat, and when the placing of the ridges makes no difference as to its wetneſs. However, as this is repreſented by thoſe perſons as important, ſome attention ſhall be given to what they ſay.

SOME adviſe the placing the ridges ſouth and north; and the reaſon which they aſſign for this, is, that thereby the ſun may have an equal influence upon all parts of the ridge.

OTHERS, again, adviſe the placing the ridges eaſt and weſt; and the reaſon which they aſſign, is, that they may ſhelter each other from the cold north wind.

WHICH of theſe advantages is the greateſt, is uncertain. It is even uncertain whether they can be called advantages at all.

IT may be diſputed, whether, in the

winter-ſeaſon, cold or heat is moſt beneficial to land. That heat is beneficial and cold deſtructive to plants, is certain. But cold poſſibly may be as proper as heat for preparing land for the nouriſhment of plants. It is allowed, that the coldneſs of the north wind, is in ſome meaſure owing to the quantity of ſalts that it carries along with it. Theſe ſalts are beneficial to land; and therefore an expoſure to the north ſeems to be rather a benefit than a diſadvantage. This is confirmed from obſervation. The lands on the north ſide of riſing grounds are, generally ſpeaking, more fertile than thoſe on the ſouth-ſide. It is certain, that the richeſt lands in Scotland have this ſituation, and are expoſed to the north.

It may be diſputed likewiſe, whether the north or the ſouth ſide of an eaſt and weſt ridge has moſt benefit from the ſun in ſummer. It is not to be denied, that the rays of the ſun fall more directly on the ſouth ſide of the ridge; but then let it be obſerved, that the north ſide has the benefit of the ſun's rays in the mornings and evenings, when the ſun is ſo low, that the ſouth ſide is under the ſhade; which may poſſibly balance the loſs ſuſtained by the greater obliquity of the ſun's rays about mid-day.

THESE things have been mentioned, to ſhow, that it is uncertain, which way of placing ridges expoſes the land beſt to the influence of the ſun and air; and therefore, that, in placing them, it is needleſs to have any view to this. When the placing of ridges makes no difference as to the wetneſs of land, then we are chiefly to have in view the conveniency of ploughing and laying out the land in proper breaks.

CHAP. XVII.

Of ploughing in ridges.

THERE are three different ways of ploughing ridges: gathering, caſting, and cleaving.

GATHERING keeps the crown and furrows of the ridge in the ſame place in which they were before. The plough begins in the crown, and ploughs out the ridge, turning the earth towards the crown, where it entered. Every ridge is ploughed by itſelf; or, inſtead of this, the halves of two contiguous ridges may be ploughed together. By this method of ploughing, the ridge is higher raiſed than before. It is obvious, that, as the earth on each ſide is turned upon the crown, and thrown up out of the furrows, the ridge is raiſed, both by making the crown higher, and the furrows lower.

CASTING keeps the crowns and furrows likewiſe in the ſame place, in which they were before. The ridges are ploughed in pairs. The plough may enter in the furrow betwixt the ridges, and plough out the ridges, turning the earth towards the furrow, where it entered. Or the plough may enter in the furrow on the right ſide of the two ridges, then turn to the one on the left, and plough out the ridges, turning the earth to theſe furrows, and from the furrow that is betwixt them. By this method of ploughing, the ridges are kept of the ſame height in the crown, and one of the furrows made a little higher, and the other a little lower than before. The earth is taken from one furrow, and thrown into the other, and this is done alternately through the field. If this is reverſed at next ploughing, that is, the earth turned into the furrows from which it was taken at the former ploughing, thereby the ridges are preſerved in the ſame ſituation.

CLEAVING is the reverſe of gathering. The plough enters in the furrow on the right ſide of the ridge, turns to the furrow on the left ſide, and ploughs out the ridge, turning the earth from the crown towards the furrows. Every ridge is ploughed by itſelf; or, inſtead of this, the halves of two contiguous ridges may be ploughed together. If the ridge is raiſed in the crown, by this method of ploughing it is made flatter. It is obvious, that, by this method of ploughing, earth is thrown into the furrows, by which they are made higher; and that earth is taken from the crowns, by which they are made lower. If the ridge is already flat, by this method it is changed, and the crown turned into the furrow.

When a field is laid out in the manner judged moſt proper, with reſpect to the breadth and height of the ridges, it ſhould be ploughed in one or other of theſe ways mentioned, according to its ſituation. If the ridges are broad and high, caſting will be found to be the moſt proper method of ploughing. For this is the only way by which they can be ploughed, and yet kept in the ſame ſituation: Cleaving will make them flatter; and gathering will raiſe them higher. * If they are flat and narrow, cleaving will

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* If land ploughed in this manner is harrowed acroſs the ridges; thereby ſome of the earth is taken from the crowns, and left in the furrows; by which the ridges are made flatter. This makes it neceſſary ſometimes to gather the ridges, that thereby they may be raiſed to their proper height.

be found to be the beſt method. Cleaving flat ridges, and thereby turning the crowns into furrows, and the furrows into crowns, has theſe peculiar advantages: A field is much ſooner ploughed in this way, than in any other; and a quantity of freſh earth, at every ploughing, is expoſed to the air, and employed in vegetation: and the ridges being kept level, are ſown with exactneſs. In no caſe gathering is proper, unleſs when the proper ſituation of the ridge renders it rather too wet for winter-grain *.

It may not be improper, in this place, to conſider a method of ploughing, uſed in ſome places, called *ribbing*. This method of ploughing is performed by making furrows about two feet diſtant from each other: one half of the ſurface is untouched by the plough, and the other half, which the plough turns up in making the furrows, is thrown on the top of what remains faſt. The land may be ploughed in this manner, either without regard to ridges; or the plough may be made to enter and turn, as it does in gathering, caſting, or cleaving; that is, a ridge may be ribbed in the way of gathering or cleaving; and two ridges may be ribbed in the way of caſting. This kind of ploughing is ſeldom practiſed but in the beginning of winter, and upon land to be ſown with barley, after two more clean ploughings. It does not prevail ſo much as formerly, and is very much condemned by our modern improvers. But, however much it may be condemned, it certainly has its uſes. It keeps the land dry; the rain that falls is confined to the furrows, from whence the looſe earth is taken, and eaſily finds its way off. It facilitates the rotting of the ſtubble, by covering it and keeping it dry; it makes the froſt penetrate a greater quantity of the ſoil; and it alſo expoſes a larger ſurface to the influence of the air. Theſe things make this kind of ploughing, in ſome caſes, preferable to a clean ploughing.

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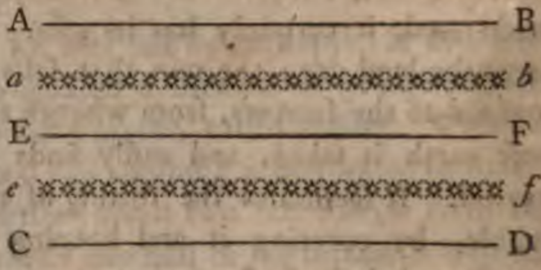
* When it is ſaid, that, in no caſe, gathering is proper, it is ſuppoſed that the ridges are already laid out in the moſt proper manner.

There is a method of ploughing uſed in England, as mentioned by ſome of the writers on huſbandry, called *bouting*. It is performed by throwing the earths of two furrows towards each other upon ſome faſt land. This is certainly an improvement upon the Scots method of ribbing, and better anſwers all the purpoſes of it. For the better underſtanding how this way of ploughing is performed, let A B C D repreſent a part of a ridge, to be ribbed in this manner. The plough goes firſt from A to B; by this the earth, *a b*, is thrown upon ſome faſt land: the plough next goes from F to E, at ſuch a diſtance from A B as not to turn back the earth *a b*, but to throw ſome more earth on the top



of it: then the plough returns in the track E F, which throws up the earth *e f*; and next goes from D to C, at the ſame diſtance from E F, that E F is from A B. By this are made two ribs and three furrows; and, in the ſame manner, a whole field may be ploughed. The advantage of this above the ordinary method of ribbing is this: When the field is ploughed again, the work may be reverſed, the faſt land that was left turned up, and a ſurface, entirely new, expoſed to the influence of the air. To reverſe this, the plough goes firſt from *b* to *a*, by which the half of the earth *a b*, with the faſt land below it, is turned into the furrow A B: the plough next returns from *a* to *b*, by which the other half of the earth *a b*, with the faſt land below it, is thrown into the furrow E F: then the plough goes from *f* to *e*, by which the half of the earth, *e f*, with the faſt land below, is thrown into the furrow E F, on the top of the laſt half of *a b*. The plough next returns from *e* to *f*, by which the other half of the earth, *e f*, with the faſt land below it, is thrown into the furrow C D; and ſo on through the field. By this ribs are placed where furrows were before, and furrows where ribs were before; and the ſurface is entirely changed, what was above turned down, and what was below turned up. Theſe two ploughings may be performed with the ſame ſtrength, and in the ſame time with one clean ploughing; and, it is probable, that, upon trial, in ſome caſes, will be found more beneficial.

As a further improvement of this method of ploughing, it is propoſed to rib the land, and, at the ſame time, to plough it clean. This is done by throwing the earths of three or four furrows together in ſuch a manner, as to leave no faſt land below; and is the ſame thing with ploughing the land in ridges about three feet broad, from the middle of one furrow to the middle of the other. Thi ſerves all the purpoſes of the other kin of ribbing, and, beſides, has theſe fu ther advantages; the land being cle plough ploughed, weeds are more effectually deſtroyed, and the ſoil is better opened for receiving benefit from the froſt and air. This method may likewiſe be reverſed by another ploughing. The ſurface may be entirely changed, and the ribs turned into furrows, and the furrows into ribs *.

THESE

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* IT will not be improper to ſhow, how this work is to be performed in the moſt exact manner. In order to this, a bridle, or muzzle, muſt be uſed, ſuch a one as is deſcribed in chap. 5. of this book, and the cattle muſt be yoked in a line before each other. Let us ſuppoſe, that the ribs are to be made with four furrows. The cattle muſt be placed in the furrow on the left ſide of the ridge, and the cleek of the ſwingletree on the muzzle, to the left of the beam; ſo that, when the cattle are going in the furrow, the plough may go about four or five inches to the right of it. At the land-end, the cleek muſt be placed in ſuch a manner, that when the cattle return in the furrow made by the plough, the earth of the furrow, with the faſt land below it, may be turned back. This done, the cleek muſt be put to the middle of the beam, and the cattle put in the furrow of the ridge, as at firſt. By this the few inches of faſt land, betwixt the furrow of the ridge and the furrow firſt made, will be taken off, and laid up. This makes a rib of three furrows; the fourth is added by the cattle going with the cleek placed in the ordinary way. To begin making the ſecond rib, at a proper diſtance from the firſt, the cattle muſt be put into the furrow laſt made, and the cleek placed ſo far to the left of the beam, that the

plough

THESE different methods of ploughing, the laſt two excepted, are known to every common ploughman, and they ſhould be

plough may go about four or five inches from the furrow in which the cattle are going. After the firſt is made, the other three may be made as before directed.

IF the ribs are to be made by three furrows inſtead of four, the firſt rib is to be made as before directed; and, when this is done, the plough muſt turn to the furrow on the other ſide of the ridge, and make a rib there in the ſame manner; from thence it muſt turn to the ſide of the ridge where it firſt entered, and there, the cattle going in the laſt-made furrow of the firſt rib, and the cleek placed on the left of the beam, the diſtance of the two ribs from each other is determined, as in the four furrowed ribs. When this is done, the plough muſt go to the other ſide of the ridge; and ſo from one ſide to another, making ribs alternately on each, till the whole is ploughed. The reaſon why the plough muſt go from one ſide of the ridge to the other, in making three furrowed ribs, is obvious: Without this there can be no certain way of regulating the diſtance of one rib from another. In this way of making three furrowed ribs, it may be obſerved, that two of the furrows are turned towards the crown of the ridge, and the third towards the furrow. If it is found more convenient to turn the two to the furrow, and the third to the crown, the plough muſt enter in the crown of the ridge, and make ribs on each ſide alternately, till the ridge is ploughed out.

IF ridges are narrow, and do not divide equally into ribs, two or three of them may be ribbed as one ridge.

attended to by every improver, as of importance; without a proper knowledge of them he cannot give directions to his ſervants, nor prevent them from falling into blunders in the execution, which they are but too apt to do. The ignorance of a maſter in things which his ſervants are acquainted with, is attended with bad conſequences; it gives them an indifferent opinion of his knowledge of farming, and makes them deſpiſe every new thing which he propoſes, as abſurd and whimſical.

It was obſerved, that ploughmen are apt to commit blunders in ploughing. Thus in gathering ridges, if care is not taken in beginning the ploughing of the ridge, ſome firm land will be left in the crown, and the crown itſelf ſo much raiſed above the reſt of the ridge, that no ſeed will lie upon it. It is ſometimes obſerved, that juſt on the crown of a ridge, where the ſoil is deepeſt, there is leſs corn, and more root-weeds, than in any other part of the ridge. This is certainly occaſioned by allowing firm land to remain there in ploughing, and by raiſing the crown like a peak above the reſt of the ridge. The ploughman, inſtead of turning back the earth of the firſt furrow, and the firm land below it, keeps at ſuch a diſtance, as to lay the earth of the ſecond furrow up to it, or on the top of it. This leaves firm land betwixt the furrows, and raiſes the crown of the ridge to a peak. But if he is directed to draw the furrows ſo near, as to turn back the earth of the firſt in making the ſecond, no firm land will be left, and the earth, that by the other method is thrown upon the crown, will be ſcattered.

THIS blunder is oftener committed when flat ridges are cleaved. In cleaving, if the ridges are ploughed out turning the plough always to the left, it is impoſſible to prevent the two furrows, laid together in the crown of the new ridge, from being at too great a diſtance, and raiſed higher than the reſt of the ridge. When ridges are cleaved in this manner, the earth of the firſt furrow that the plough makes, is turned over upon firm land, and backed by the earths of the other furrows in their courſe. This makes it impoſſible to get at this firm land in ploughing the next ridge, without turning up the firm land itſelf, and the earth of the furrow laid over it, upon the top of the earth of the ſecond furrow, by which the crown of the ridge would be raiſed to a high ſharp peak. Now, to prevent this, the ploughman, in ploughing the next ridge, keeps at a proper diſtance, and does not touch the firm land, over which the earth of the firſt furrow is laid. But it may be obſerved, that he muſt either keep at ſuch a diſtance as to leave firm land in the crown of the new ridge equal to the breadth of two furrows, or he muſt turn the earth of his furrow upon the top of the earth of that firſt furrow. By this the crown of the ridge is ſtill high raiſed, and ſome firm land ſtill left.

BUT ridges of this kind may be cleaved without leaving any unploughed land, or without raiſing the crown much above the reſt of the ridge. The method of doing it is this: After the plough has made the firſt furrow, inſtead of turning to the left, and making a furrow on the other ſide of the ridge, it turns to the right, and throws back the earth of its firſt furrow along with the firm land below it; and after going round again in the ſame courſe, turns to the other ſide of the ridge, and goes twice round in the ſame manner, after which the ridge betwixt the two *fierings*, as they are called, is ploughed out, as at firſt propoſed. When the ploughing of the ridge is finiſhed, a new fiering is made in the next furrow, by the plough going twice round, as before directed, and then the ridge betwixt the laſt-made fiering and the ploughed land is ploughed out in the ſame manner as before; and in the ſame way the fierings are made till the whole field is ploughed. By this method there is no firm land left below the earth of the furrow; and the earth that is turned towards the crown being ſcattered, and not laid all in one place, the crown itſelf is not much raiſed above the reſt of the ridge.

It may be obſerved likewiſe, that in caſting ridges, if care is not taken, the furrow towards which the earth is thrown will be ſo filled up as to be improper for a drain. The plough enters the ridge near the furrow, and throws the earth towards it, turns to the right, and throws the earth from the oppoſite ſide towards it likewiſe; and then goes in the track of the old furrow, betwixt the earths of the furrows made on each ſide. This furrow, towards which the earth is thrown, is ſometimes ſo filled up as to render it improper for a drain. We have ſhown how the earth around it is ploughed. The furrow which the plough makes going in the track of the old furrow, betwixt the earths of the furrows on each ſide, is called *a gore-furrow.* On the left ſide, the plough having no mold-board, the looſe earth falls back into the furrow behind the plough, and fills it up, or at leaſt makes it unfit for a drain, which in wet land is a great diſadvantage.

But this may be prevented by proper

care; the furrow may be made clean, and fit for a drain. The method of doing it is this: The plough enters about two feet from the furrow, and inſtead of turning to the other ſide, returns on the ſame ſide, turning back the earth, and then goes round again in the ſame courſe; after this turns to the other ſide of the furrow, and does the ſame, goes twice round. By this the gore-furrow is made quite clean, and, like the crowns of ridges, formed at about two feet diſtance on each ſide.

SOME other things of a like nature might be mentioned. Theſe have been inſiſted upon, to ſhow, that it is neceſſary to attend to every circumſtance of ploughing, that ſo this important work may be performed in the moſt proper manner.

CHAP. XVIII.

Of harrows.

THE harrow is the inſtrument b
which the ſurface is made ſmoot
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after ploughing. One horſe is ſufficient to draw the one commonly uſed. Sometimes three of them go abreaſt, and ſometimes only two. When the ſurface is very rough, two are reckoned ſufficient for the attention of one perſon; but when three can be uſed, they make better work, and are nearly equal to two pair.

THERE are ſeveral different kinds of harrows uſed in Scotland. The kind that is moſt common needs not be deſcribed, as it is ſo well known, and as there is no great art required in making it.

WHEN the land is rough, the harrows are apt to ſtart, and get atop of each other. To prevent this, ſome perſons fix pieces of crooked timber to the outſide bulls, that are contiguous to each other, which ſtretching a little over, thereby prevent the harrows from ſtarting up, and keep them in their proper place. Others couple the harrows together in ſuch a manner, as to allow them to go before, and fall back of each other, and at the ſame time turn upon

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a hinge. This way, in ſome reſpects, has the advantage of the other; for the harrows are kept cloſe together, and they keep each other by their mutual weight from ſtarting over the clods. But then it has this diſadvantage: if the driver is not very attentive, one of the horſes will get both harrows to draw.

WHEN ſtiff land is ploughed wet, it is raiſed in large pieces; and theſe pieces, when dry, become ſo hard, that the common harrows make no impreſſion upon them. To reduce this kind of land, a large harrow, called a *break*, has been contrived. There are different kinds of this harrow. One kind is of the ſame ſhape with the common harrow; another kind is of a triangular form. This one is drawn by the corner, and has teeth fixed both in the ſides and behind. Both kinds are made heavier or lighter according to the kind of ſoil for which they are intended. Some of them are made ſo heavy as to require ſix or eight cattle to pull them. It is very improper to uſe the heavieſt kind of them in land where there are large or faſt ſtones; for in going their weight will not allow them to ſtart over theſe, as the ſmall harrows do, but being intangled, are torn aſunder by the cattle.

THERE is another kind of harrow, which, though but little uſed as yet, will be found moſt beneficial in many caſes. It is of the ſame form with the common harrow, only a great deal broader; the bulls are placed at a greater diſtance, and conſequently the teeth thinner placed; the teeth themſelves are very little thicker than the teeth of the common harrow, but much longer, and thoſe in the fore-part ſet in ſuch a manner as to ſlope forward. It is made of ſuch a weight, as to be eaſily drawn by two horſes. It is obvious, from the conſtruction of this harrow, that it will go deeper than the common harrow. The teeth being thinner ſet and longer, and thoſe in the fore-part of the harrow ſloping forwards, naturally make it go deeper. It makes the land opener than the common harrow, covers the ſeed deeper, and is more proper for tearing up roots. It ſeems alſo to be the moſt proper harrow for breaking turf: the common harrow goes over turf without making much impreſſion; the break-harrow tears up the turf in large pieces, and throws it in heaps; but this harrow, by having its teeth long, ſharp, and thin placed, will break it in pieces. It is not indeed pretended, that it will be effectual for this purpoſe; but it is certain, that the teeth of this harrow will tear ſome pieces of turf, which the teeth of the common harrow will make but little impreſſion upon, and which the break-harrow will drive along before it. At the ſame time, it muſt be obſerved, that this harrow is not proper for ſtony land, or land where there are large hard clods. For its teeth, being long and ſmall, are eaſily put out of their place.

THE laſt kind of harrow that ſhall be mentioned, is the French harrow. It is of a triangular form, with a joint near the angle, to which the draught is fixed. It has two handles, by which it is made to go either deep or ſhallow. Its principal uſe is to level ſteep ridges, which it does moſt effectually. It is drawn acroſs the ridges; when at the crowns, by preſſing on the handles, the harrow goes down. and carries earth along with it to the furrows. When at the furrows, by lifting up the handles, the harrow is brought out of the ground, and the earth left behind. But this is a very improper work, unleſs where the land is very dry ſituated; and in no danger of being damaged by water. The plough can reduce high ridges as quickly as is convenient *.

CHAP. XIX.

Of harrowing.

THE chief deſign of harrowing, is, to ſmooth the ſurface. By this weeds are deſtroyed, and ſeed, if ſown, is covered.

Root-weeds, that are looſed by the

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* See chap. 15. of this book.

plough, are ſometimes torn up by the harrow, and thus are deſtroyed. When this is the deſign of harrowing, the harrows ſhould go acroſs the ridges, or rather acroſs the way that the plough has gone. Becauſe, by going acroſs the earths of the furrows, the teeth of the harrow are apter to catch hold of the roots, than if it ſhould go in the ſame way with the plough.

THOUGH the harrow may bring ſome part of the roots above ground, yet commonly ſome other parts continue below, which will grow if undiſturbed. This makes it neceſſary for perſons to follow the harrows, and gather all the roots which they obſerve brought up, and carry them off of the field, or burn them.

IF harrowing does not actually tear up the roots, it encourages their vegetation, by filling up the hollows, and thereby defending them againſt their greateſt enemy, the drought. On this account harrowing is improper for deſtroying root-weeds, excepting after a ſpring-ploughing, when the land is ſoon to be ploughed again for ſeed. For at this ſeaſon the drought is ſeldom violent, and it has not time to operate in the deſtruction of the roots; and therefore whatever the harrows bring out is ſo much deſtroyed.

THE ſame things that make harrowing improper for deſtroying root-weeds, make it very proper for deſtroying ſeed-weeds. The ſmoother that the ſurface is made, and the more effectually that the mold is broke, the ſeeds near the ſurface are the more expoſed to the air, and the ſap, which is in the land, the more effectually retained. Both theſe are neceſſary to promote the vegetation of the ſeeds; and they muſt vegetate before they can be deſtroyed. But harrowing not only promotes the vegetation of the ſeeds of weeds, but alſo deſtroys the young plants when ſprung up; ſo that one ploughing, if the ſeaſon is favourable, and ſoil allows, may be attended with ſeveral harrowings, and thereby ſeveral crops of weeds deſtroyed.

IF land riſes in hard clods, the harrow makes but little impreſſion; at leaſt before the clods are broken, the land is made ſo firm by the treading of the horſes, and the weight of the harrows, as to render the work uſeleſs, and ſometimes deſtructive. Great care ſhould therefore be taken to prevent land from being brought to this ſituation. If land once riſe in hard clods, it is vain to expect to break them with the harrow, ſo as to cover the ſeed. Unleſs the ſeaſon is very wet, it will remain in this ſituation through the ſummer, and afford but little nouriſhment for the crop. Sometimes it will remain in this ſituation after men have attempted to break the clods with malls.

IF the ſoil is light and ſpungy, it can ſcarcely get too much harrowing; for the more that it is harrowed, it becomes the firmer. But if the ſoil is ſtiff, the leſs harrowing it gets the better, if the purpoſes propoſed are anſwered. The effects of harrowing are in this caſe contrary to thoſe of ploughing. Ploughing renders ſtiff ſoil more free and open, but harrowing renders it ſtill more firm and ſolid.

The ordinary way of harrowing after ſeed is ſown, is firſt along the ridges, then acroſs, and then along again. If ridges are flat, they may be harrowed either along or acroſs; and the work may be begun or ended either way. But if the ridges are ſteep, it is improper to begin by harrowing acroſs, becauſe thereby too much of the ſeed will be drawn into the furrows. If the ridges are very ſteep, for the ſame reaſon, it is improper to harrow acroſs at all. For another reaſon it is thought improper to harrow acroſs ridges when the land has been ploughed immediately out of lea or graſs. In ploughing this kind of land, the ſward is for the moſt part turned over whole; ſo that when the harrow goes acroſs, inſtead of tearing the ſward, it is apt to turn it back into the furrow from whence it was taken. When ridges are gathered or caſt, this will probably happen. In caſting, the earths of the furrows on one ſide of the ridge are turned towards the crown; and, in gathering, the earths of the furrows on both ſides are turned the ſame way; and therefore the harrows, when drawn from the crown to the furrow, are apt to take hold of the unbroken ſward, and turn it back. But this does not ſo readily happen when the ridge is cloven. Becauſe in cleaving, the earths of the furrows on both ſides of the ridge being turned from the crown, the harrows, in going up from the furrow, are not in ſuch danger of turning them back. In ploughing lea, the earths of the furrows are ſometimes placed as exactly as poſſible upon their edge, that ſo they may be the more eaſily torn by the harrows. When theſe are turned to the crown, they do not ſupport each other; and are therefore eaſily turned back by the harrow, in going from the crowns to the furrows: but when the earths are turned to the furrows, they ſupport each other by their weight; and therefore are not ſo eaſily turned back by the harrows

rows in going up from the furrows to the crowns.

C H A P. XX.

Of the roller.

THE roller is an inſtrument alſo uſed in tillage. Like the harrow, it ſmooths the ſurface. There are ſeveral kinds of rollers. One kind is made of ſtone; another of a log of wood; another of caſt iron: but the one that is moſt common, and moſt eaſily procured, is made by nailing narrow boards upon three wheels, one in the middle, and the other two at the ends of the roller. The only eſſential difference in rollers is in their weight. As in ſome caſes a heavier, and in others a lighter one is needed, the roller is generally made in ſuch a manner, that weight can be eaſily added to it, or taken from it.

THAT the draught may be the eaſier, and two or more horſes yoked with [illegible] conveniency, the diameter of the roller is made great. But the greater that the diameter is made, the greater weight muſt be added to the roller: for the greater that the diameter is, the greater part of its ſurface reſts upon the ground, and, conſequently, the leſs impreſſion it makes. It is neceſſary, therefore, that the weight of the roller bear a proportion to the greatneſs of the diameter, that ſo the ſame effects may be produced. The turning the kind of roller commonly uſed, is very ſevere upon the cattle: for, in turning, the roller does not move upon its axis, but is dragged along the ſurface. To remove this inconvenience, a kind of roller has been lately contrived, with a diviſion in the middle, as if two rollers were joined together. This kind turns very eaſily: for, in turning, both parts move round their axis: the one moves forward, and the other back.

THERE is a kind of roller, mentioned by the author of the new ſyſtem of agriculture, for dividing turf into pieces for burning. This roller has hoops around it, at two feet diſtance from each other; the hoops with ſharp edges, raiſed about ſix inches above the ſurface of the roller. This, he ſays, drawn over a field, acroſs the way it is to be ploughed, will make the earths of the furrows riſe in pieces of two feet length. This, it muſt be owned, would be a very expeditious way of cutting the turf. But it is to be feared, that either the roller muſt be exceſſively heavy, or the land exceſſively ſoft, to make it anſwer the purpoſe.

CHAP. XXI.

Of rolling.

ROLLING is practiſed with ſucceſs, both on land lying in graſs and on land in tillage. It is of advantage to land in graſs, by preſſing down mole-hills and mole-runs. Some ſay, that it alſo deſtroys fog *.

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* See book 1. chap. 13.

When land is laid down in graſs for hay, rolling is of uſe in ſmoothing the ſurface; and, when laid down in graſs for paſture, it makes the graſs ſtool, (tiller), and grow thicker.

There is a kind of land, which, when clover is ſown upon it, throws out the young plants after froſt. Rolling, in the beginning of winter, and immediately after the froſt is gone, it is ſaid, will, in ſome meaſure, prevent this. The firſt rolling prevents the froſt from penetrating ſo deep, as otherwiſe it would do; and the ſecond makes the land firm, after having been looſed by the change from froſt to open weather.

Rolling may alſo be uſed with advantage upon land in tillage. When the land is naturally ſtiff, and may be reduced by the harrow, rolling is very improper: for it makes this kind of land ſtill firmer than the harrow does. But if the land riſes in clods, which the harrow does not reduce, rolling is very proper; for it ſmooths the ſurface, and breaks the clods, more effectually than harrowing.

When the land is light and ſpungy, the roller ſhould always be applied after ſeed is ſown; for it is ſcarcely poſſible to make this land too firm.

It was obſerved, that, to deſtroy root-weeds, land ſhould be made rough, and raiſed in as large pieces as poſſible; and that it ſhould be allowed to lie for ſome time in that ſituation. Rolling, after this, is of great uſe; for, without it, if the weather continues dry, it will not be poſſible to make the land fit for receiving another ploughing.

If the land is ſoft below, and ſome hard clods upon the ſurface, which the harrow does not break, rolling may be uſed with ſome advantage: for, beſides ſmoothing the ſurface, it will bruiſe ſome of the clods; and ſuch of them as are preſſed down, will be diſſolved by the natural fermentation of the ſoil, if in good heart.

Sometimes in ſtiff land, ploughed dry, after a former wet ploughing, or when, by any accident, it has been much trod upon, the whole riſes in hard clods, which the harrows cannot break, ſo as to cover the ſeed. In this caſe rolling is of great uſe. It bruiſes ſome of the clods; and, when followed by the break-harrow, theſe clods are raiſed up and broken. Though rolling ſhould do no ſervice but ſmooth the ſurface, yet, on that account, it ſhould be practiſed. For when the ſurface is ſmooth, the corn may be cut down more expeditiouſly than when it is rough and uneven. When graſs-ſeeds are ſown for hay, it is abſolutely neceſſary to ſmooth the ſurface: the roller is moſt proper for this. Some uſe it before, and ſome after ſowing. When it is uſed before ſowing, the ſeed is more equally ſcattered.

Grass-ſeeds muſt be ſown in ſuch a manner, as to lie near the ſurface; otherwiſe they will not vegetate. The making the land firm by rolling is therefore an advantage, as, by it, the ſap is better preſerved; and this does not ſo much damage to graſs as to corn, for the ſeveral kinds of it are commonly better foragers. ×

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BOOK III.

Of MANURES, and their Operation.

CHAP. I.

Of the deſign.

IT has already been obſerved, that there are ſubſtances, which, when mixed with the earth, greatly promote vegetation. Theſe are called *manures*. To apply manures in ſuch a manner, as moſt effectually to promote vegetation, it is of importance to know their natures, and the ways in which they operate. This is the more neceſſary, as, without it, we cannot know how to apply them in the moſt proper manner to the different ſoils.

To inquire into theſe things is the deſign of this book.

CHAP.

CHAP. II.

Of the different ways in which manures operate.

MANURES operate in all the different ways by which vegetation is promoted.

THEY operate, by communicating to the ſoil with which they are mixed, the vegetable food which they contain; by communicating to it a power of attracting this food in greater plenty from the air; by enlarging the vegetable paſture which it contains; and by diſſolving the vegetable food which it is already poſſeſſed of, and fitting it for entering the roots of plants.

MANURES are very different in their natures. Some of them operate in all the ways mentioned; and there are none of them that do not operate in more ways than one.

GREAT miſtakes have ariſen from ſuppoſing, that manures operate only in one way. None have been attended with greater loſs, than ſuppoſing that they ſerve only to divide the ſoil, and that tillage may be ſubſtituted in their place. This is Mr Tull's opinion, and is, indeed, the fundamental principle of his horſe-hoeing huſbandry.

BEFORE one changes the ordinary practice of agriculture, in ſo important a point as baniſhing manures from his fields, the good effects of which are ſo obvious; he muſt be certain, that the principle which determines him to ſo important a change, is itſelf well-founded.

MR TULL has endeavoured to prove, that earth is the food of plants; and hence infers, that to divide the earth into minute particles, by which it is fitted for entering their roots, is all that is neceſſary in agriculture: and this, he aſſerts, may be done by tillage, without manures.

IN the firſt book, when treating of the food of plants, we have attempted to ſhow, that other principles, beſides earth, are in the compoſition of this food: and, if this is true, the want of manures, which provide theſe other principles, cannot be ſupplied by tillage.

BUT, ſuppoſing we allow, with Mr Tull, that earth is the food of plants, yet ſtill it does not follow, that tillage may ſupply the place of manures. It is certain, that every particle of earth which we obſerve, is not of the kind that is the food of plants. Every ſoil is a compoſition of different earths; ſeveral of which, it is obvious, are not of this kind.

THE great difference in ſoils equally pulveriſed, is a plain and convincing evidence of this. Now, let it be obſerved, that the earth contained in dung is of this kind; it has already been food to plants, and therefore though all that is contained in the greateſt quantity of dung laid on at one time, is but ſmall in proportion to the quantity of ſoil employed in vegetation, as Mr Tull juſtly obſerves; yet it may be conſiderable in proportion to the quantity that is really the food or *pabulum* of plants. If the quantity of earth contained in the quantity of dung commonly laid on at one time, is compared with the quantity of earth contained in the richeſt crop, it will be found ſeveral times larger; and therefore, by the laying on of this dung, food is provided for ſeveral good crops.

BESIDES, let it be obſerved, that the mechanical action of the plough cannot increaſe the number of the particles by which plants are nouriſhed; they are ſo ſmall as not to be obſerved in water. Mr Tull ſuppoſes, that they are as ſmall as thoſe upon which the colour of bodies depends. Now, though pounding earth in a mortar may perhaps do ſomething to increaſe them, yet the action of the plough can never be ſuppoſed to do it. The plough can do no more than open the ſoil, or enlarge the paſture of plants, and allow them to extend their roots in ſearch of their food, but does not increaſe the quantity of it; and therefore tillage cannot ſupply the place of dung, which not only opens the ſoil by its fermentation, but alſo increaſes the vegetable food by the earth which it contains.

IT may be further obſerved, that the fermentation raiſed by dung continues for a conſiderable time; ſo that though, by ploughing, the ſoil may be as completely divided as by the fermentation of dung, yet it will not continue ſo: for after ſeed is ſown, the artificial paſture raiſed by ploughing is continually decreaſing while the crop is growing; whereas the artificial paſture, raiſed by the fermentation of dung, is continued by the continuance of this fermentation; and therefore, though in the horſe-hoeing huſbandry the want of dung may be ſupplied by hoeing, yet, as Mr Tull indeed obſerves, dung is ſtill neceſſary in the old huſbandry.

IF perſons attentively conſider the effects of manures, it will appear that they operate in all the ways mentioned.

MANURES are found to enrich the beſt pulveriſed ſoil, and to do this again and again, after it is exhauſted by crops. It is almoſt an univerſal practice in Scotland, to lay dung upon land that is kept conſtantly in tillage once in three, four, or five years. It is obſerved, that after the dung is laid on, the land becomes rich, and that the crops turn gradually worſe and worſe, till the whole virtues of the dung are exhauſted; and it is alſo obſerved, that immediately upon the dung being again applied, the land becomes rich as before. It is natural to conclude from this, that dung promotes vegetation by increaſing the quantity of the vegetable food.

IT is found, that ſome manures loſe part of their virtues by being long expoſed to the air. After dung is ſufficiently rotten, the longer that it lies it becomes of leſs value, and does not enrich ſo large a quantity of land as when uſed in proper time.

them to extend their roots in ſearch of their food, but does not increaſe the quantity of it; and therefore tillage cannot ſupply the place of dung, which not only opens the ſoil by its fermentation, but alſo increaſes the vegetable food by the earth which it contains.

It may be further obſerved, that the fermentation raiſed by dung continues for a conſiderable time; ſo that though, by ploughing, the ſoil may be as completely divided as by the fermentation of dung, yet it will not continue ſo: for after ſeed is ſown, the artificial paſture raiſed by ploughing is continually decreaſing while the crop is growing; whereas the artificial paſture, raiſed by the fermentation of dung, is continued by the continuance of this fermentation; and therefore, though in the horſe-hoeing huſbandry the want of dung may be ſupplied by hoeing, yet, as Mr Tull indeed obſerves, dung is ſtill neceſſary in the old huſbandry.

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It is found, that ſome manures loſe part of their virtues by being long expoſed to the air. After dung is ſufficiently rotten, the longer that it lies it becomes of leſs value, and does not enrich ſo large a quantity of land as when uſed in proper time. The dung of cows dried upon their paſture, gathered, and laid upon other land, is ſcarcely to be diſcerned in its effects on the crops produced: the ſame quantity applied, whether carried from the byre, or by folding the cattle, enriches the land. From this it is obvious, that this kind of manure contains the vegetable food in itſelf, and does not receive it from the air.

It is found, that ſome manures operate the ſooner, and with the greater violence, the longer that they are expoſed to the air before they are uſed. Lime and marles are of this kind; the longer they lie expoſed, they operate the ſooner; and it is obſerved, that they have a ſtrong power of attracting the virtues of the atmoſphere. From theſe things it is reaſonable to infer, that theſe manures operate, by communicating to the ſoil with which they are mixed, a power of attracting the vegetable food from the air.

It is obſerved, that ſome manures exhauſt land of its vegetable food, and do not reſtore it again when immediately applied. This is found to be the caſe with lime. Land thoroughly limed has been found to carry many very good crops: by degrees however the virtues of it have been exhauſted, and the land reduced to a worſe ſituation than before the lime was laid on. In this ſituation lime has been applied a ſecond time, but its effects found to be far inferior to what they were when firſt applied. This is ſufficient to convince us, that this manure operates by diſſolving the vegetable food which it meets with in the ſoil, and fitting it for entering the roots of plants.

IT is certain, that all kinds of manures open the ſoil. Any perſon will be convinced of the truth of this, who will take the trouble to compare a piece of land, on which dung, or any other manure has been laid, with a piece contiguous that has not been manured; he will find the one much ſofter, much more free and open than the other. It muſt be allowed, therefore, that all manures operate by enlarging the vegetable paſture.

CHAP. III.

Of the different kinds of manures.

MANURES are commonly divided into claſſes. Some divide them into natural and artificial; others divide them into the foſſil, the vegetable, and the animal; and treat of them in order, as belonging to each of theſe claſſes.

THE manures belonging to ſome of theſe claſſes, differ both in their nature and operation from thoſe in the other claſſes. Some of them likewiſe differ from others in the ſame claſs. The dividing them into claſſes, therefore, ſerves no purpoſe. All that is neceſſary is, to treat of the different particulars which the farmer can command, without conſidering to what claſs they belong.

MANURES to be procured in Scotland

are theſe following; dung, marles, aſhes, ſoot, ſea-weed, ſhells, ſown vegetables, and water.

THERE are ſeveral other things that are very rich manures, ſuch as rags, leather, *&c.* But as theſe are to be procured only in ſmall quantities, it is needleſs to treat of them ſeparately.

CHAP. IV.

Of dung.

DUNG is commonly uſed to ſignify not only the excrement of animals, but alſo all rotten vegetables, when uſed as manures. In treating of it in this chapter, we underſtand it in the firſt ſenſe of the word.

DUNG is the food by which animals are nouriſhed, reduced to a corrupted ſtate. The ſtomach diſſolves the food of the animal, and reduces it to a ſtate of putrefaction much ſooner than is done by the air.

It is by being in this ſtate of putrefaction that the juices fit for the nouriſhment of the body are conveyed by the guts into the blood. While bodies are in a ſound ſtate, their parts adhere firmly together, and they are incapable of being turned into the parts of other bodies. To render them capable of this, they muſt be reduced to their firſt principles. This is done by corruption. It is obſerved, that by corruption all the parts of bodies are relaxed, and the ſalts, oils, and other juices which they contain, from being fixed, are made volatile. It is by being reduced to this ſtate in the ſtomach, that the things which the animal feeds upon become nouriſhment to it, and are turned into parts of its body.

ALL the juices contained by the things which animals feed upon, are not exhauſted by the guts; many of them, along with the earthy part of the food, are thrown out. There is no doubt that ſome of the earthy part of the food goes alſo to the nouriſhment of the animal; but as the earth is rendered volatile by the ſalts and oils, there muſt be but a ſmall quantity of it, in proportion to the quantity of theſe, exhauſted by the animal; and therefore in the dung there muſt be a great quantity of earth in proportion to the other principles. However, as the dung contains all the principles of the food, we may conſider the dung of thoſe animals that feed on vegetables, as vegetables in a putrefied ſtate.

Of the ſame nature is the dung of animals that feed upon other animals. Vegetables are the original food. All animals either feed on pure vegetables, or on other animals that feed on vegetables. Animals that feed on vegetables are made up of the ſame things with vegetables, only under a different form; and therefore the dung of animals that feed upon theſe, is ſtill to be conſidered as vegetables in a putrefied ſtate.

Chymists inform us, that dung is compounded of the ſame principles of which vegetables are compounded, of water, air, oils, ſalts, and earth. The earth which it contains is of the abſorbent kind, and attracts the other principles. They alſo inform us, that dung attracts and ferments with acids, and by this fermentation produces ſalts. A quality of ſalt, as was before obſerved, is to attract and diſſolve oils, and make them capable of being mixed with water.

IF theſe qualities of dung are conſidered, it will appear that it promotes vegetation in all the different methods mentioned in the ſecond chapter.

IT promotes vegetation by increaſing the vegetable food. It is compounded of the ſame principles of which the vegetable food itſelf is compounded, as we endeavoured to ſhow, when treating of the food of plants. This is alſo confirmed by the experience of all places and all ages; and it is what no perſon will doubt of, who conſiders that it has the ſame effects upon land of all kinds, and in all ſituations.

It promotes vegetation by enlarging the paſture of plants, it attracts acids from the air and ſoil; and by raiſing a fermentation with them, thereby ſeparates the particles of the ſoil with which it is mixed. Every farmer knows the truth of this from experience. The land upon which dung is laid, though naturally ſtiff, becomes ſoft and mellow, and is more eaſily ploughed than before.

Dung, we have ſaid, enlarges the paſture of plants, by attracting acids, and fermenting with them. Theſe acids are in the ſoil and air. They are in the ſoil: for the ſoil produces acid plants. Chymiſts tell us, that the neutral ſalt found in ſoil is compounded of an alkaline ſalt, ſuch as is found in vegetables, and an acid ſpirit. All alkalis are ſtrong attractors of acids, ſo that, in the proceſs of an experiment upon ſoil, perhaps it may be difficult to keep them ſeparate, though they may exiſt ſeparate in it. The acid plants prevent theſe from mixing; or, perhaps, have a ſtronger power in their veſſels to ſeparate them, than other plants have.

BUT though there may be no acids in ſoil, excepting in the compound of neutral ſalts; yet there is no doubt, but they are in the air. Chymiſts find this by innumerable experiments. Aſhes, when expoſed to the air, produce neutral ſalts; the application of acids has the ſame effects. Any perſon may obſerve a ſalt adhering to the lime of old walls; this ſalt is not in the lime, it is produced by the air. The ſame ſalt is produced by acids. Other experiments might be mentioned, but theſe are ſufficient.

DUNG promotes vegetation, by communicating to the ſoil a power of attracting the vegetable food from the air. The earth which it contains, is of the abſorbent kind, and attracts all the other principles of the vegetable food; and the ſalts which it contains and produces, attract oils.

It likewiſe promotes vegetation, by preparing the vegetable food for the nouriſhment of plants. By the ſalts which it contains and produces, it not only attracts oils, but alſo diſſolves them, and makes them capable of being mixed with water. It is probable, that oil is a principal part of the food of every plant which we cultivate in our fields, at leaſt is the ingredient of which it is eaſieſt to exhauſt the ſoil, and which it is moſt difficult to reſtore to it again. In proportion to the quantity of oil contained in any plant, in proportion it robs the ſoil by which it is nouriſhed of its vegetable food. But the nature of oil muſt be changed before it can enter the roots of plants. This change is made by ſalts; they diſſolve it, and make it to mix with water.

Though dung promotes vegetation in all theſe ways mentioned; yet, as there are other bodies, that are much ſtronger attractors of acids, by which many of its effects are produced; it is probable, that it principally operates by increaſing the food of plants. Its effects in diſſolving the vegetable food in the ſoil, muſt be very trifling. The ſalts which it contains and produces, having its own oils to work upon, and being along with them conveyed into the roots of plants, cannot operate with any violence upon the oils which the ſoil contains. This is confirmed by experience. When the virtues of dung are exhauſted, the ſoil is no poorer than before it was laid on.

SOME new improvers are pleaſed to ridicule the old farmers, becauſe they are ſo fond of dung; but none will do this who attentively conſider the virtues of it. Such other manures as can be obtained, are to be uſed; and tillage is carefully to be attended to: but none of theſe are to ſuperſede the uſe of dung, which can be employed to ſo great advantage.

THE author of the new ſyſtem of agriculture takes upon him to aſſert, that dung deſtroys ſome land; and that it is as great folly to apply dung to land that requires cooling, as to adminiſter poiſon to a man in a fever. He tells the farmers, that they miſs a crop by dunging an improper ſoil, and lay on more dung to remedy the misfortune. Theſe aſſertions may impoſe upon a man that is fond of novelty and paradox; but, with men of ſenſe and experience, they muſt bring into diſcredit every thing that ſuch an author aſſerts.

THOUGH dung in general has all the qualities mentioned, yet there are ſome kinds of it poſſeſſed of ſome of theſe qualities in a higher degree than others. There are as many kinds of dung as there are of animals, and in ſome reſpects they all differ one from another.

THE difference betwixt one kind of dung and another, is commonly ſuppoſed to ariſe from the different food of the animals. Green herbage, ſtraw, or hay, do not contain ſo much vegetable food in the ſame quantity as grain does. Hence it is ſuppoſed, that the dung of cows is not ſo rich as that of horſes, nor the dung of horſes ſo rich as that of fowls.

BUT this difference muſt partly ariſe likewiſe from the nature of the animals, if it is true, that the dung of horſes, cows, ſheep, hogs, and geeſe, all differ one from another, though fed upon the ſame paſture. Some animals digeſt their food more quickly than others. This makes a difference in the dung produced by the ſame food. Some things are digeſted, and turned into a ſtate of corruption by ſome animals, that paſs thro' others ſound and undiſſolved. The matter then in the ſtomach that digeſts the food, muſt be different in the different animals. The dung muſt partake ſomething of the nature of this, which makes another difference in the dung produced by the ſame food.

SOME writers in agriculture treat of the dung of the different animals ſeparately. But it is needleſs to do this; for it requires more pains and expenſe to keep them ſeparate, and uſe each of them by itſelf, than all the advantages ariſing from this way, above the ordinary way, can poſſibly amount to.

THE dung of fowls, particularly of pigeons, is an exception to this. It is commonly uſed without any mixture, and it can be kept ſeparate from other dung without any trouble or expenſe. It is obſerved, with reſpect to it, that the effects of it are more violent, and ſooner over, than the effects of common dung. The effects of ſome other kinds of dung would perhaps be the ſame, if they were uſed without any mixture. The pigeons dung, being thoroughly corrupted, ſoon diſſolves, and becomes vegetable food. But the ſtraw, with which the other kinds of dung are commonly mixed, not being ſo thoroughly corrupted, prevents the effects of them from being ſo violent, and ſo ſoon over.

THE way in which pigeons dung operates, points out the manner in which it ſhould be applied. As it is very rich, and its qualities ſoon exhauſted, a very ſmall quantity ſhould be applied, in proportion to the quantity of other dung. If care is not taken of this, the crop will be deſtroyed by being too luxuriant. Perhaps, mixing it with ſome other things may have good effects. The ſtrawing ſmall chaff of any kind, from time to time, on the bottom of the pigeon-houſe, is very proper. The chaff ſucks up the moiſture, and makes it eaſy to reduce the dung to powder, which is an advantage: for thereby the dung is ſcattered more equally, and manures a greater quantity of land.

It is a cuſtom, in ſome places, to fold ſheep and cattle, for the ſake of their dung; which, in this way, is uſed without any mixture. Some writers on huſbandry give particular directions how to do this in the moſt advantageous manner. But it is needleſs to conſider theſe. The farmer muſt conſult the advantage of his ſheep and cattle, and not the advantage of the land by the dung; and, therefore, muſt fold them in the moſt convenient manner. A ſcore of ſheep, with the beſt management in folding, will not produce much more than ten ſhillings worth of dung, in the ſeaſon, above the expenſe of folding; a ſum ſoon loſt by an injudicious management of them.

CHAP. V.

Of dung mixed with vegetables in a dunghill.

DUNG is commonly mixed with vegetables, and allowed to lie for ſome time before it is uſed.

STRAW is thrown below the cattle, and this is carried out along with the dung, and thrown upon the dunghill. On the dunghill is alſo thrown all the ſtraw that is left after ſerving other purpoſes, and all the refuſe of vegetables and animals, uſed in the farmer's family.

In the management of dunghills, two things are always to be kept in view: The promoting putrefaction; and the preventing the vegetable food from flying off into the air, or being conveyed away by water. The ſtraw and other parts of uncorrupted vegetables, of which the dunghill is compounded, make it neceſſary to keep the firſt in view; and the ſalts and oils, which by corruption are rendered volatile, and the water, which extracts the virtues of dung, make it neceſſary to keep the laſt in view.

To promote putrefaction, the ſituation of the dunghill ſhould be dry, and the dung laid together as thick as is convenient. Putrefaction, indeed, cannot be promoted without water: but the quantity that falls in rain, with the natural ſap of the dung, is ſufficient for this purpoſe. Too much water prevents that fermentation, which carries on the proceſs of putrefaction moſt quickly. This is confirmed by experience. If there is any part of a dunghill ſoaked with water, it is obſerved that the ſtraw is quite ſound, while, in other parts that are dry, it is completely rotten.

To promote putrefaction, the dung ſhould be laid thick together; thereby the heat is the ſooner generated, that produces the putrefaction; and thereby the natural ſap is the better preſerved, which prevents the dung from being burned.

When the natural ſap of the dung is exhaled, and the dung afterwards covered, the heat is in danger of riſing to ſuch a height, as to burn the dung. This muſt be carefully guarded againſt: for, when the dung is burned, its ſtrength is exhauſted, and it is rendered almoſt uſeleſs. Dung, in this ſituation, is dry and white; the ploughmen call it *fire-fanged.* When thus burnt, it is found, from experience, that it has loſt almoſt all its virtues. To prevent the dung from being reduced to this ſituation, when it is carried out of the ſtable or byre, particularly if there is much ſtraw in it, it muſt not be laid in heaps, which makes it dry too faſt, but carefully ſpread thick upon the top of the dunghill. This prevents the ſap from being carried off by the wind, and thereby prevents the heat from being raiſed to ſuch a height as to burn the dung.

IT may be obſerved, that, when graſs is cut green, and immediately thrown into a heap, it heats, and this heat ſoon reduces the graſs to a ſtate of putrefaction. But, if the graſs is for ſome time expoſed to the air, and then put together without being ſufficiently dry, it heats alſo; but, inſtead of being reduced to a ſtate of putrefaction, is burned. So it is with dung: If, when carried out, it is laid in ſmall heaps, being thereby too much expoſed to the air, it loſes its ſap; and, being afterwards covered, the heat is raiſed to ſuch a height, as to burn it: but, if it is ſpread thick upon the top of the dunghill, it retains the ſap, and putrefies.

A DISTINCTION is here made betwixt dung putrefied and burned; and this diſtinction is repreſented as important. I know not if the chymiſts make any ſuch diſtinction. A late author ſays, that the greater part of what remains of dung, after the putrefaction is completed, ſeems to be earth, and a fixed alkali. Theſe things, we apprehend, make up the greater part of what remains, when dung is what we have called *burned*; but when it is only putrefied, it contains alſo ſalts and oils. But though chymiſts ſhould make no ſuch diſtinction, it is abſolutely neceſſary that the farmer do it: for, when the dunghill is allowed to heat to ſuch a degree, as to burn the dung, the value of it is thereby greatly leſſened.

To prevent the vegetable food from being conveyed away, no foreign water, excepting what falls in rain, muſt be allowed to run into the dunghill; and the ſituation of the dunghill, if poſſible, ſhould be high at the ſides, and hollow in the middle. When foreign water is allowed to run into the dunghill, the fermentation is not only ſtopped, but, as it is often neceſſary to allow the water a paſſage from it, thereby much of the vegetable food is conveyed away. When the bottom of the dunghill is quite level, the rain, which ſometimes falls in heavy ſhowers, eaſily finds its way off; but this is prevented by making it high at the ſides, and hollow in the middle.

THE only way to prevent the vegetable food from being exhaled by the ſun, or carried off by the wind, is to cover the dunghill. The covering the dung would certainly be an advantage, if it could be eaſily executed. If it was not for the additions that are daily made to it, earth would be very proper for this purpoſe. Some perſons aſſert, that, by covering the dunghill, it would loſe the influence of the air; and it is the air alone, they ſay, that makes it fit nouriſhment for vegetables; and, therefore, recommend the expoſing it, particulary to the north and north-eaſt; becauſe the wind from theſe points brings along with it more aëreal nouriſhment than from the others. If the dunghill contained no vegetable food, but what it received from the air, this direction would be very proper: but, as the dunghill contains in itſelf all the ingredients of the vegetable food, and as its juices, the more it is putrefied, become the more volatile, the vegetable food in it by being expoſed to the air, inſtead of being increaſed, would be diminiſhed. The covering the dunghill, therefore, would be an advantage. But the difficulty lies in executing this.

Some propoſe to dig a large pit, lay the bottom with flags, build up the ſides with ſtones, and cover it with a roof. This, it muſt be owned, will retain the juices, and promote corruption, as well as prevent the vegetable food from being exhaled. But then it muſt be ſo expenſive, that few will be engaged to make trial, unleſs the benefits are more obvious than the aſſertions of the contrivers make them: and, beſides the expenſe, it muſt likewiſe be attended with inconveniencies. In ſome ſituations, it will be very difficult to prevent too much water from getting into it; and as difficult to get the dung itſelf carried out.

THE method which we propoſed for preventing the dung from over-heating, will alſo, in a great meaſure, ſerve this purpoſe. The dung, when it comes from the ſtable or byre, is mixed with ſtraw, which abſorbs the juices, and prevents them from flying off, till the ſtraw itſelf begins to putrefy. When, in this ſituation, it is laid thick upon the top of the dunghill, a ſmall ſurface only being expoſed to the air, and being covered before the ſtraw begins to putrefy, the juices, in a great meaſure, are preſerved. A perſon, by the ſmell, is ſenſible that the juices of the dung are not ſo volatile, when firſt laid upon the dunghill, as after they have been covered for ſome time, and then expoſed to the air.

DUNG, expoſed to the ſun and wind, or waſhed by rain, loſes its vegetable food; it ought, therefore, to be ploughed in as ſoon as is poſſible, after it is laid upon land. Some perſons aſſert, that they have found from experience, that dung is nothing worſe, though it lie a conſiderable time ſpread upon land, in dry weather, before it is ploughed in. This, if true, is contrary to what has been ſuppoſed, that the vegetable food is exhaled by the ſun, and carried off by the wind. It is probable, that, after dung is ſpread upon land, its fermentation ceaſes, and the ſalts and oils remaining in it may become fixed, and may continue ſo till a new fermentation is raiſed by mixing the dung with the ſoil; and that, by attracting acids from the air, more ſalts may be formed. By this its effects will be more ſudden and violent, but ſooner over.

It may be proper alſo to obſerve, that as the juices contained in the dung are waſhed downwards by the rain, it ſhould be ploughed in with a very ſhallow furrow; excepting when the dung is not ſufficiently rotten. In this caſe it requires a deep furrow to cover it.

The better that dung is mixed with the ſoil, the purpoſes of vegetation are the better anſwered; all parts of the ſoil receive equal benefit, the vegetable food is equally diſtributed, and in all parts the fermentation equally promoted. When dung then is laid on land, it ought to be ſpread as equally as poſſible. This likewiſe prevents the breeding of vermin, which happens in ſome ſoils, when the dung is left in too large pieces.

CHAP. VI.

Of lime.

Some are of opinion that lime is only a ſtimulus, that is, that it promotes vegetation, only by making the ſoil with which it is mixed, exert itſelf. Others, that it promotes vegetation by enriching the land, and adding to the quantity of vegetable food.

The firſt ſupport their opinion by obſerving, that the crops which lime enables land to produce, exhauſt it in a remarkable manner. It is a certain fact, that land thoroughly limed, may be reduced to a much poorer condition by cropping, than land can be reduced to, that is not limed. It is poſſible to reduce limed land almoſt to a *caput mortuum*; and the better and the oftener the land is ploughed, this is done the ſooner.

The other opinion is ſupported by obſerving, that, in ſome places, lime is applied regularly once in four or five years; that the land ſeldom gets any other manure; that it is kept almoſt conſtantly in tillage; and, with the aſſiſtance of fallowing, carries very good crops.

From theſe obſervations, one is led to conclude, that lime acts both ways; not only makes land exert itſelf in the nouriſhment of vegetables, but alſo enriches it, and adds to the vegetable food.

AN inquiry into the qualities of lime will probably illuſtrate this.

CHYMISTS tell us, that lime has the following qualities.

IT is a great diſſolver of all animal and vegetable ſubſtances: it is a very heavy body: it is an attractor of acids; with theſe it raiſes a fermentation, and produces ſalt; and it communicates its virtues to water.

WHEN theſe things are conſidered, it will appear, that lime promotes vegetation in theſe ways following.

IT communicates to the ſoil a power of attracting the vegetable food from the air. It attracts the acids from the air and ſoil; theſe it converts into a neutral ſalt, by which oils are attracted from the air. This operation of lime is confirmed by the experience of thoſe who uſe it as a manure once in four or five years.

LIME enlarges the vegetable paſture. By its weight it penetrates the ſoil *; and, by its fermentation with acids, it ſeparates its particles.

THIS operation of lime is obvious to every perſon that views with attention any land that is thoroughly limed. It apears ſoft and mellow, and obviouſly in a ſtate of fermentation.

LIME diſſolves the vegetable food, and fits it for entering the roots of plants. It diſſolves all the animal and vegetable ſubſtances which it meets with in the ſoil, and converts them to vegetable food; and, by the ſalts which it produces, it diſſolves all oily ſubſtances in the ſoil; and conveys them into the roots of plants. We find from experience, that lime clears land of root-weeds. This it does by its diſſolving power. Root-weeds, when

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* IT is neceſſary to obſerve, that if the ſoil is light and ſpungy, and has no ſolid bottom, lime, by its weight, will ſoon penetrate beyond reach of the plough. This kind of ſoil is therefore not proper for it.

torn up by the plough, have their growth checked, and are for ſome time in a languiſhing condition: if lime is applied to their roots while in this ſituation, by its diſſolving power, it is apt to deſtroy them.

THAT it is owing to the ſalt which lime produces by its attracting and fermenting with acids, that it chiefly owes its power of promoting vegetation, is confirmed by this obſervation. The lime of old walls which has been long expoſed to the air, and where this ſalt is already formed, is much more ſudden in its operations, when laid upon land, than quicklime.

IT has been obſerved, that lime promotes vegetation by communicating to the ſoil a power of attracting the vegetable food from the air, by enlarging the vegetable paſture, and by diſſolving the vegetable food, and fitting it for entering the roots of plants. It is probable, that the two laſt are the ways by which it chiefly operates.

By this it exhauſts the land of its vegetable food. For it cannot be ſuppoſed to attract from the air a ſufficient quantity of food for the nouriſhment of the crops which it enables the land on which it is laid to carry; and it contains none of this food in itſelf. This is confirmed by experience. If land upon which lime has been laid, is exhauſted by crops, the application of lime a ſecond time has not the ſame effect as before; unleſs the vegetable food is ſupplied by dung, or the land allowed to reſt for ſome years, and have the vegetable food ſupplied by the air.

Thus it appears, that lime from its nature muſt act both as a ſtimulus and a manure; while it makes the earth exert itſelf in the nouriſhment of vegetables, in ſome meaſure alſo enriches it, and adds to the vegetable food.

IN ſome lands, the diſſolving the vegetable food, and fitting it for entering the roots of plants, may be moſt beneficial: in others, the communicating the power of attracting the vegetable food from the air, may be moſt beneficial. It will not be improper, therefore, to point out how lime is to be applied, that ſo it may chiefly anſwer the one or the other of theſe purpoſes.

IN uncultivated land, in which there is a large quantity of vegetable ſubſtance, lime ought to be uſed chiefly as a ſtimulus: and when improved land needs a recruit of vegetable food, it ought chiefly to be uſed as a manure.

WHEN lime is intended for a ſtimulus, a large quantity ſhould be applied at once. For it takes a conſiderable quantity to diſſolve roots, and the other vegetable ſubſtances in the land, and to produce a high degree of fermentation.

WHEN lime is intended for a manure,

a ſmall quantity applied at a time is ſufficient. It is probable, that it requires only a ſmall quantity of lime to impregnate a large quantity of earth, and to communicate to it an abſorbent quality, in as high a degree as it is capable of receiving: and it is certain, that it is in proportion to the abſorbent quality which it communicates, that the ſoil is enriched by it. This is not mere conjecture. It is certain, that a ſmall quantity of lime will impregnate a large quantity of water, and communicate to it all its virtues, and theſe in as high a degree too as it is capable of receiving: it is not improbable, that it may operate in the ſame manner upon earth *. If a ſmall quantity of lime communicates an abſorbent quality to a large quantity of earth, but has not ſuch influence in diſſolving vegetable ſubſtances, or in producing fermentation, it follows, that the ſmaller the quantity is which is applied, it will operate the more as a manure; and the greater the quantity applied, it will operate the more as a ſtimulus.

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* See Dr Alſton on lime-water.

It is proper to obſerve likewiſe, that when lime is applied in ſmall quantities as a manure, it is neceſſary to repeat the application frequently; for it is probable, that the ſoil by action loſes the abſorbent quality, which the lime communicates.

These things which we have obſerved concerning the operation of lime in ſmaller and larger quantities, are, in ſome meaſure, confirmed by experience. They are agreeable to the practice in thoſe parts where lime is moſt uſed. When barren land is to be improved, it is laid on in large quantities; and when it is applied to land already improved, it is laid on in ſmall quantities, and frequently once in three or four years.

As lime operates by attracting acids from the air, the longer that it lies expoſed to the air before it is ploughed in, it will exert itſelf the more quickly, and with the greater violence. Some alledge, that this ſhould not be done in ſummer.

For they ſay, that the ſun acts contrary to the air: as the air ſupplies the ſalt, the ſun exhales it, and communicates it again to the air.

As lime, when laid on in large quantities, exhauſts land of its vegetable food, it is neceſſary to ſupply this food by dung, or ſuch other manures as have it in greateſt plenty; or the land ſhould be managed in ſuch a manner, as to prevent, as much as poſſible, the vegetable food from being exhauſted. Laying off land, after a very few crops of corn, into graſs for paſture, is the moſt proper way of doing this. Land, when paſtured, has not its vegetable food ſo much exhauſted, as when it carries corn. The quantity of vegetable food carried off in fleſh, by the cattle, or conveyed to the air by their perſpiration, bears but a ſmall proportion to the quantity carried off by a crop of corn and ſtraw.

It is neceſſary further to obſerve, that, as lime communicates its virtues to water, land inclining to be wet, and from which the water has free acceſs away, is not proper for it: for the water, in running off, carries along with it the virtues of the lime. X

X Vid. Addit:s, &c p. 32. (where the quantity of lime for an acre is mentioned; viz. 60 bolls of shells, — Winchester measure, for improving outfield: never limed before he seems to mean.)

CHAP. VII.

Of marles.

THERE are a variety of marles, which are commonly reduced to three ſorts: The clay, the ſtone, and the ſhell.

THE firſt has its name from its ſimilitude, in appearance, to clay; the ſecond from its hardneſs, and ſimilitude to ſtone; and the third from the ſhells, with which it is mixed, or rather of which it is compounded *.

THE clay and ſtone marles are of the ſame nature; the ſhell marle is very different from both. This makes it neceſſary to treat of them ſeparately.

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* THOUGH the ſhells of which this marle is compounded, are quite putrefied; yet they ſtill retain their ſhape and figure. An animal having a reſemblance to the ſhells in the marle, 'tis ſaid, is to be ſeen in ſome mariſhes.

CHAP. VIII.

Of clay and ſtone marles.

MARLE of theſe kinds promotes vegetation in a ſurpriſing manner. It is probable, however, that it contains in itſelf few of the principles of which the vegetable food is compounded. Plants are not able to find their food in it. When in a bed below the ſurface, it reſiſts the entrance of water, like till or clay. When near the ſurface, and turned up by the plough in great quantities, the ſoil is little better than till, almoſt quite barren. The method of its operation will be beſt known by inquiring into its qualities.

IT is obſerved, that both the clay and ſtone marles have the following qualities.

WHEN long expoſed to the air, or put into water, they fall down into a powder:

they are very heavy bodies: the earth of which they are compounded, is of the abſorbent kind: they are attractors of acids; with them they raiſe a fermentation, and produce ſalts.

THE only difference betwixt them is this: The clay marle is ſooner diſſolved than the ſtone marle; and commonly has a ſtronger power of deſtroying acids, and *producing ſalts.* Dr Home ſays, that *the clay* marle, which he tried, deſtroyed a third more of acids than the ſtone marle.

THESE marles ſeem to have much the ſame qualities with lime; and, therefore, muſt operate in the ſame manner.

THEY communicate to the ſoil a power of attracting the vegetable food from the air; they enlarge the vegetable paſture; and they diſſolve the vegetable food that is in the ſoil, and prepare it for entering the roots of plants.

These marles communicate to the ſoil a power of attracting the vegetable food from the air. The abſorbent earth which they contain, and the ſalts which they produce, are ſtrong attractors of oils.

It is obſerved, that they attract oils ſo ſtrongly, that they are uſed by ſome to extract greaſy ſpots from cloaths. When laid upon land, they will therefore attract oil from the air, which is the ingredient of the vegetable food moſt wanted.

These marles enlarge the paſture of plants. They ferment with acids, and fall down into powder, when expoſed to the air, or put into water. Theſe things make them operate in ſeparating the particles of the ſoil, with which they are mixed.

These marles alſo prepare the vegetable food for being nouriſhment to plants. The ſalts which they produce, not only attract oils from the air, but alſo from the ſoil; diſſolve theſe oils, and render them capable of being mixed with water; and of being conveyed by it into the roots of plants.

ACCORDING to ſome, theſe marles contain ſome oily matter. This, if true, would make them operate in a manner different from lime. But this is uncertain. The earth of which theſe marles are compounded, is of the abſorbent kind; it cannot be long expoſed to the air, without attracting oils; and, therefore, though they contain none in their original compoſition, yet ſome marks of them may appear upon trial.

THESE marles are long in diſſolving. Large pieces of the ſtone marle are ſeen ſometimes undiſſolved, ſix or ſeven years after it has been laid upon land. This makes it neceſſary to apply a very large quantity of them, otherwiſe their effects will not be known.

As the quantity of marles applied is very great in proportion to the quantity of lime, land, when manured with marle, muſt have a ſtronger power of attracting the vegetable food from the air; and therefore the marle ſhould be preferred, when it can be as eaſily obtained.

As the earth of theſe marles is of the abſorbent kind; as a great quantity of it is applied at one time; and as it is long in diſſolving, it muſt be many years before its operation ceaſes; and, if the land is barren, the nature of it will be changed, and ever after, by the ſame kind of dreſſings it received before, will continue to carry better crops. x In this reſpect alſo it is preferable to lime. This advantage, however, depends, in a great meaſure, upon the nature of the ſoil. If the ſoil is ſoft and ſpungy, and has not a firm bottom, the marle, by its weight, will, by degrees, penetrate, like lime, beyond the reach of the plough; and, therefore, must leave the ſoil no better than it found it.

ALTHOUGH, in ſome reſpects, there

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marles ſeem preferable to lime, yet we are to conſider, that their principal operation is the ſame with that of lime; which is enlarging the paſture of plants, and fitting the vegetable food for entering their roots. When land, therefore, manured with them is exhauſted by crops, it cannot receive much benefit from them a ſecond time, if immediately applied. This is confirmed, 'tis ſaid, by experience. It is obſerved, that marle, when applied a ſecond time to land exhauſted by crops, has not the ſame effect as when firſt applied. X

Vid. Additns, p. 39.

As marle operates in the ſame manner as lime, it follows likewiſe, that limed land exhauſted by crops, can receive little benefit from the application of marle; and that marled land, exhauſted by crops, can receive little benefit from the application of lime. As it exhauſts the vegetable food, the proper manure after it is dung, which contains this food in the greateſt plenty.

IT was obſerved, that marle operates

chiefly by attracting oils and acids from the air; the longer, therefore, that it lies upon land, expoſed to the influence of the air, the more quickly it will operate.

THE difference betwixt the clay and ſtone marles was ſaid to conſiſt in this: That the clay marle diſſolves ſooner, and has a ſtronger power to deſtroy acids and produce ſalts. This kind is therefore preferable, as a leſs quantity will produce the ſame effects. If Dr Home's experiments are to be depended upon, or rather, if all clay and ſtone marles have the ſame powers with thoſe which he made his experiments with, then four cart-load of the clay marle is equal to five of the ſtone.

WHAT was ſaid of lime, with reſpect to the application of it in ſmaller and larger quantities, may likewiſe be ſaid of marle. When barren land is to be improved, the marle ſhould be laid on in large quantities: but when land is in good order, the applying a little [illegible] [illegible] part of the quantity commonly uſed, once in ſix or ſeven years, may have very good effects.

CHAP. IX.

Of ſhell marle.

SHELL marle is very different in its nature from the other two. It is commonly claſſed among the animal manures.

IT does not diſſolve with water, as the other marles do. It ſucks it up, and ſwells with it, like a ſpunge. It is a much ſtronger attractor of acids than they. Dr Home ſays, that it takes ſix times more of acids to ſaturate it than any of the other marles which he had met with. But the greateſt difference betwixt the ſhell marle and the other marles conſiſts in this. The ſhell marle contains oils. It is uncertain if the other marles contain any oils; but this kind, it is ſaid, contains them in great plenty.

THIS marle, it would ſeem, from the qualities which it poſſeſſes, promotes vegetation in all the different ways. It increaſes the food of plants; it communicates to the ſoil a power of attracting this food from the air; it enlarges the paſture of plants; and it prepares the vegetable food for entering their roots.

IT increaſes the food of plants by the oils which it contains, and the ſalts which it produces: By theſe ſalts, and by the abſorbent quality which it poſſeſſes, it communicates to the ſoil a power of attracting this food from the air. It enlarges the paſture of plants, by its ſwelling with water, and the fermentation which it occaſions; and it prepares the vegetable food for entering the roots of plants, by the ſalts it produces in fermentation.

IT will not be improper to attend to the effects of theſe different operations. The communicating vegetable food immediately to the ſoil, and communicating to it a power of attracting this food from the air, have the ſame effects. By both theſe operations the vegetable food is increaſed.

The enlarging the paſture of plants, and fitting the vegetable food for entering their roots, have alſo the ſame effects. By both the vegetable food is diminiſhed. It is obvious, that, by theſe operations, plants are aſſiſted in extracting this food from the ſoil.

The oils which it contains, it is probable, are ſoon exhauſted: having a ſtrong power of attracting acids, and forming ſalts, it is natural to ſuppoſe that theſe ſalts do more than work upon its own oils; they will alſo attract and diſſolve the oils which they meet with in the ſoil; and would exhauſt it of the vegetable food which it contains, was it not for the ſtrong abſorbent quality which it communicates. This quality, it is probable, remains after the operation of the ſalts is over; and thus, upon the whole, the ſoil is rather bettered by it.

We had occaſion to ſhow, that the difference betwixt poor and rich ſoil conſiſteth in the different powers of attraction. As this marle has ſo ſtrong an abſorbent quality, if it is applied in large quantities, and frequently repeated, it is poſſible that it may communicate ſuch an attractive power to the ſoil, as to enrich it in a very high degree, ſo as to need no further manuring, but by proper tillage may be made to attract from the air in the winter-ſeaſon ſuch a quantity of vegetable food as is ſufficient to nouriſh a crop in ſummer.

As this kind of marle does not exhauſt land of its vegetable food, as the other marles or as lime do, it may be applied to land exhauſted by them, or it may be repeated. As it diſſolves ſooner than the other marles, its effects will be more ſudden; and as it does not diſſolve ſo ſoon as dung, its effects will not be ſo ſoon over.

A late author ſuppoſes, that the marle found below moſs is compounded of earth and the alkaline ſalts of rotten wood. He explains in what manner he imagines it is formed. If there is a marle compounded of theſe ingredients, it is different from any of the marles that have been mentioned. However, it will operate much in the ſame manner. It will communicate a power to the ſoil of attracting the vegetable food from the air; it will enlarge the paſture of plants, and it will prepare the vegetable food for entering their roots.

As it contains a large proportion of ſalt, its effects will be ſudden and violent. It is not proper therefore that a great quantity of it ſhould be applied.

As its effects are ſudden and violent, it cannot be expected that they will laſt long. It is probable that they will be ſoon over after it is entirely diſſolved.

THE ſalts which it contains, will make

it operate chiefly in diſſolving the vegetable food in the ſoil, and fitting it for entering the roots of plants. By this it will exhauſt the ſoil, if care is not taken to prevent it, by the application of dung, or turning the land from tillage into graſs for paſture.

THERE is another kind of marle that goes under the name of *ſhell marle*, and in ſome parts of the country is found in great plenty. It ſeems to be almoſt wholly lime, and it operates in the ſame manner.

CHAP. X.

Of aſhes.

ASHES contain a large proportion of ſalt; they attract acids more violently than any other thing as yet known, but they ſoon loſe their virtue.

THE effects of aſhes will then be of the ſame kind with lime. But as aſhes contain ſalt, their operation will be more ſudden; as they attract acids with greater violence, and ſooner loſe their virtue, their operation will be more violent, and ſooner over. This is confirmed by experience. The firſt crop after land is manured with aſhes is commonly very luxuriant, and the ſecond crop exhauſts almoſt the whole of their virtues.

As the effects of aſhes are ſudden and violent, they ſhould be applied in very ſmall quantities; and as they operate in the ſame way with lime, they ſhould not be applied to land exhauſted by lime or marle; ſhould not be followed by theſe, nor repeated.

In this chapter it is proper to conſider the burning of turf as a manure.

Turf is compoſed chiefly of vegetables; that which remains then after burning, muſt be of the ſame nature with aſhes. To theſe the fertility communicated to the ſoil is chiefly owing. It is found from experience, that in proportion to the number of roots contained in the turf the burning turns out to advantage; and therefore land, with a tough ſward of graſs upon it, is recommended as the kind moſt proper for being improved in this manner.

THE heat which part of the ſoil receives from burning the heaps of turf, is ſuppoſed to contribute to its fertility: but this can have little influence except to deſtroy any ſeeds or roots of weeds that may be in the land.

IN burning the turf, care muſt be taken to cover the heaps in ſuch a manner as to prevent the fire from breaking out into flame. Where this happens, it is obſerved, that the aſhes loſe part of their virtue, and that the parts of the field manured by them are not ſo much enriched as the other parts are by the heaps of turf that are burned without flame. It is natural to think, that the earth of the turf, when properly piled up, will retain the oils of the vegetables, and prevent them from aſcending into the air in ſmoke and flame.

This makes ſome difference betwixt the manuring by burning and the manuring by aſhes. However, as the oils contained in burned turf are in very ſmall quantities, we may well ſuppoſe that they will ſoon be exhauſted by the ſalts; and therefore, though the effects of burning may be more violent, yet will be equally ſudden, and as ſoon over.

To prevent burnt land from being exhauſted, one crop only, or two at moſt, ſhould be taken, and then turned into graſs for paſture. If a little dung is added after the firſt crop, its fertility will be the longer preſerved.

A late writer pretends to point out a method, by which poor land treated in this manner may be enriched for many years, and which, he ſays, was a ſecret before. The method he points out is, to dung the ſecond year after burning. It is not to be doubted, that the aſhes, having the vegetable food of the dung to work upon, will have a better effect, and exhauſt the ſoil much leſs than when there is no dung mixed with it. If the laying on of the dung is delayed till the fourth year, ſays our author, it will have no effect. If the truth of this was aſcertained by repeated experiments, we would be obliged to acknowledge that dung does not operate in the manner we have deſcribed. But it is probable, that our author meant no more by this, than that the laying on of dung the ſecond year is by far more advantageous than delaying it till the fourth. Dung, as has been obſerved, has every property of a manure; not only enlarges the vegetable paſture, and fits the vegetable food for being nouriſhment to plants, but alſo contains this vegetable food in itſelf; and therefore, if it is laid on in a proper manner, and in ſufficient quantities, will enrich land, whatever is its kind, or in whatever manner exhauſted. Our author ſays, that the applying marle inſtead of dung will have the ſame effect.

What he ſays will indeed rather hold true of marle than of dung. Land exhauſted by burning will not be recovered by marle, for they operate much in the ſame way. If the marle is applied before the land is exhauſted, it will preſerve it ſome time by the power it communicates of attracting the vegetable food from the air. It is more than probable, however, that all the benefit ariſing from the application of marle in this manner would not anſwer the expenſe *.

CHAP. XI.

Of ſoot.

SOOT cannot be procured in ſuch large quantities as to be uſed by itſelf, excepting in the neighbourhood of large cities; it is needleſs therefore to inſiſt much upon it.

IT contains oil, ſalt, and earth. Theſe, it ſeems, are compounded in ſuch a manner as to be ready to be conveyed into the roots of plants by water. For the effects of ſoot, when ſpread upon the ſurface, are diſcovered immediately after the firſt rain. It promotes vegetation in the ſame manner as dung, or ſhell marle. It increaſes the food of plants by the ingredients of the vegetable food which it contains. It enlarges the paſture of plants, enables the ſoil to attract the vegetable food from the air, and prepares it for entering the roots of plants by the ſalt that it contains, which is of the alkaline kind, attracts and ferments with acids, and attracts and diſſolves oils.

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* See Complete body of huſbandry, p. 93.

As it contains great plenty of vegetable food, and as its effects are ſudden, it muſt be laid on in very ſmall quantities. Sowing it in the ſpring on winter corn or graſs, ſeems to be the moſt proper way of uſing it.

When the quantity laid on is but ſmall, and its effects ſudden, it cannot be ſuppoſed to laſt long. Its virtues are commonly exhauſted by one crop.

WHEN its effects are over, the ſoil is left in the ſame ſituation as before it was laid on, not exhauſted of its vegetable food, as by lime or aſhes; and therefore it may be repeated; or it may be followed by theſe manures, as it is very proper to be applied to land that is exhauſted by them.

CHAP. XII.

Of ſea-weed, or ware.

ALL the plants that grow upon the rocks within reach of the ſea, are good manures. Thoſe that grow upon the rocks that are almoſt always covered by the water, are the richeſt.

SOME kinds of ſea-weed are burnt for kelp. This, it is thought, turns out to greater advantage than uſing them as manures. The beſt kinds for manures cannot

not be reached, as their roots are almoſt always below water; but they are frequently driven on ſhore by the ſea. A conſiderable quantity of them may always be expected on the ſhore in the neighbourhood of the rocks, where they grow, when a ſpring-tide, heavy rain, and a high ſwelling ſea all happen at the ſame time. The ſpring-tide expoſes their roots to the air, the freſh water falling in rain looſes the roots, and the high ſwelling ſea tears them up. Sometimes the tide carries them to a conſiderable diſtance.

THEY are of a ſoft pulpy nature, eaſily diſſolve, and ſoon putrefy; and they contain oil, ſalt, and earth. They muſt promote vegetation therefore in the ſame manner as dung or ſoot.

THEIR effects are ſooner over than thoſe of dung mixed with vegetables from a dunghill; for they ſooner diſſolve and ſooner putrefy.

THEY may be applied to ſoil in any ſituation, and are very proper for land that is exhauſted by lime or aſhes.

WHEN their effects are over, the land is in no worſe a ſituation than before they were applied, and any kind of manure may be applied after them.

THE oftener they are applied, the land becomes the richer. For the earth of which they are compounded, is of the abſorbent kind. This is confirmed by experience. The lands near the ſhores, where theſe ſea-weeds are in greateſt plenty, and have been long uſed as manures, are amongſt the richeſt in Scotland, and have been kept almoſt conſtantly in tillage.

THEY are preferable to dung in this reſpect, that they do not produce ſuch a quantity of weeds. Every perſon that has uſed theſe manures, knows, that weeds do not appear in ſuch plenty upon land manured with ſea-weed, as upon land manured with dung. This ſeems to confirm the opinion of thoſe, who aſſert, that the great quantity of weeds that appear upon dunged land, are produced by ſeeds mixed with the dung. But it is ſubmitted, whether this difference is not owing to the great quantity of ſalts contained in the ſea-weed and applied with it, which at firſt deſtroys ſome of the ſeeds and roots of weeds. Salt, applied in too large a quantity, is undoubtedly a poiſon to many plants. According to Mr Tull's experiments, a ſmall quantity of ſalt water deſtroyed a plant of mint. It is obſerved likewiſe, when any graſs upon the ſhore is overflowed by a ſpring-tide, it withers away in a few days, and does not recover till it gets a plentiful ſhower. Then indeed, by the freſhneſs of its verdure, it is diſtinguiſhed from the graſs that was not overflowed by the ſalt water. That it is the ſalt in the water that deſtroys the plants, is obvious: for the ſame quantity of freſh water would have had no ſuch effect. And it is probable, that the oils attracted by the ſalts, and carried down by the rain, is the cauſe of their recovery.

CHAP. XIII.

Of ſhells.

IN many places, particularly near the ſea-ſhore, broken ſhells are found in beds. Theſe are uſed by ſome as a manure.

THEY ferment with acids, and, like other animal ſubſtances, contain oil, ſalt, and earth. The oil and ſalt are not in great quantities in proportion to the earth, and they take a long time in diſſolving.

THEIR operation muſt be of the ſame kind with that of ſhell marle, but ſlower and weaker.

THEY make ſome addition to the vegetable food by the ingredients of this food of which they are compounded.

They communicate to the ſoil a power of attracting this food from the air; and they diſſolve it by the ſalts which they contain and produce. And they increaſe the paſture of plants by their fermentation.

They operate chiefly by enlarging the paſture of plants, and preparing the vegetable food for entering their roots. They are ſo long in diſſolving, that the quantity of oil communicated in a ſeaſon muſt be ſmall in proportion to the ſalts which they produce. Though theſe are their principal operations, yet in them they are inferior to lime, marles, or aſhes.

As they take a long time to diſſolve, and do not operate quickly, it is neceſſary to apply them in large quantities. For without this their operations will ſcarcely be perceptible.

For the ſame reaſon it may be expected they will continue for a conſiderable time. They will continue till the ſhells are wholly diſſolved, and all their oils exhauſted in vegetation.

As they operate chiefly by enlarging the paſture of plants, and fitting the vegetable food for entering their roots; they will in ſome degree exhauſt the land of its vegetable food, though not ſo much as lime or aſhes do, as they communicate ſome oils to it in diſſolving. It is not proper therefore to apply them after lime or aſhes, to repeat them immediately, or apply lime and aſhes after them.

IF they are taken up from below the ſurface, as muſt happen moſt commonly, it is proper to allow them to lie ſome time expoſed to the air before they are ploughed down. This will not only aſſiſt their fermentation, but will alſo promote their putrefaction.

As lime, when mixed with them, takes a very ſtrong band, it is probable, that the mixing them together in the application may in ſome caſes produce very good effects.

CHAP. XIV.

Of vegetables in an entire ſtate, or ſown for manure.

IT is a practice in ſome places to ſow turnip, buck-wheat, peaſe, *&c.* on land; and when grown up, to plough them down for manures.

THESE may be called vegetables in an entire ſtate, to diſtinguiſh them from dung made of putrefied vegetables; tho' no vegetable can be a manure till it is putrefied.

As theſe vegetables receive their food from the ſoil on which they grow, it is natural to think, that when ploughed down, they do no more than reſtore what they have taken; and therefore, that by this operation land cannot be rendered more fertile than before; at leaſt, cannot communicate ſuch a quantity of vegetable food to it as may be done by frequent ploughings. For the vegetables, though ploughed down, are not all preſerved; a part of them being uncovered, is blown away by the winds. Beſides, the plants while growing cover the ſurface, and prevent the vegetable food in the air from entering the ſoil. Whereas, when land is frequently ploughed, none of its vegetable food is exhauſted, and it is expoſed to receive all the benefits from the influence of the air. But, notwithſtanding this, ſome aſſert from experience, that a crop of ſuch vegetables as thoſe mentioned, ploughed down, render land more fertile than frequent ploughings without the application of manure.

To account for this upon the principles eſtabliſhed, let the following things be conſidered.

The ſoil, manured by ploughing down a crop of vegetables, receives all the vegetable food contained in the ſeed ſown.

This quantity in peaſe and buck-wheat is not very inconſiderable. The quantity in one grain is probably as much as there is in a whole ſtalk after the ſeed is fully ripened. It is obſerved, that plants, when cut green, exhauſt land of its vegetable food, but in a very ſmall degree to what they do when allowed to carry ſeed.

Some of the plants mentioned puſh down their roots below the reach of the plough, and bring up the vegetable food lodged there to the ſurface. Peaſe, turnip, clover, and other plants puſh down their roots very far; and whatever vegetable food they find, is ſucked up; and when they are ploughed down, this vegetable food is lodged near the ſurface, and thereby the quantity within the paſture of ſome other plants, ſuch as wheat and barley, is increaſed. A late author makes a calculation of the quantity of vegetable food which clover in this manner communicates to land, and repreſents it as very conſiderable. In few places the ſoil is ſo deep as to have the vegetable food in great plenty beyond the reach of the plough; and therefore it is probable, that this author, in his calculation, makes the quantity of this food brought near the ſurface by clover much greater than it really is. However, it is certain, that, as plants puſh down their roots below the reach of the plough, they there find nouriſhment, which is communicated to their ſtems and leaves; and therefore, when theſe are ploughed down, the quantity of vegetable food near the ſurface is increaſed.

THE covering of the ſurface ſeems to be an advantage; for thereby the air in the ſoil; not having a free communication with the external air, becomes putrefied, by which a fermentation is raiſed, and the vegetable paſture enlarged. Whatever is the cauſe of this fermentation, the fact itſelf is obvious. Every farmer knows, that when the ſoil has been covered for a conſiderable time by a ſtrong crop of peaſe, or any other kind of corn laid down, and what is commonly called *ſlooming*, though naturally hard and ſtiff, becomes mellow, ſoft, and free, and obviouſly in a ſtate of fermentation. It is probable, that this is occaſioned by the corruption of the air, or of the water, which the covering of the ſurface prevents from being exhaled.

To theſe things it may be added, that it is not impoſſible but the plants when growing may ſuck in the vegetable food from the air in as great plenty as the ſoil would have done, though there had been no plants growing upon it*. If plants have this faculty, conſidering what an immenſe ſurface is expoſed by them to the influence of the air, the quantity of vegetable food required cannot be inconſiderable.

CHAP. XV.

Of water.

WATER has been conſidered as an impediment to vegetation; it is now to be conſidered as a manure.

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* See book 1. chap. 5.

IT has already been obſerved, that rain-water contains vegetable food *. Chymiſts tell us, that it actually contains a large proportion of oil. If a quantity of it is therefore collected and let in upon a field, it will leave upon it ſome of the vegetable food which it contains.

IT has been obſerved likewiſe, that when rain falls in great quantities on land which has a conſiderable deſcent, in running off, it carries along with it ſome of the fineſt particles of the ſoil, and the vegetable food contained in them †. If this water then is let in upon a field, and allowed to ſettle, the land will receive from it not only all the vegetable food contained in the rain, but alſo all that is contained in the particles of earth which it has carried off from other lands.

THIS method of manuring land can be

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* See book 1. chap. 4.

† See book 2. chap. 16. This appears likewiſe from the colour of the water, and the mud which it leaves behind it in hollow places.

uſed on ſuch fields only as lie on the ſides of rivers, and is proper only for ſuch as can be eaſily drained.

In practiſing it, care muſt be taken that the water does not run over the field with violence, but ſo gently that it may leave behind the mud which it contains. If the water is allowed to run over a field with violence, it is in danger of carrying off the vegetable food, inſtead of giving it a ſupply.

Land in graſs is the moſt proper for being manured in this manner. The firmneſs of the ſurface prevents any of the ſoil from being carried off, and the graſs entangles the mud, and any vegetables that are in the water, and prevents them from getting away.

If the river made uſe of in this manner runs through fertile land, more benefit may be expected. Its waters after rain muſt contain the greater plenty of vegetable food.

THIS operation ſhould be performed in the ſpring-ſeaſon. In that ſeaſon land in graſs ſuffers leaſt from being overflowed. Lands being almoſt all ploughed, the rain carries off the greateſt quantity of vegetable food; and in that ſeaſon it is ſaid likewiſe, that the rain-water contains the greateſt quantity of oils.

IN ſome places it is a practice, to ſet clear water over land, whether in graſs or tillage. From this practice, it is ſaid, the land receives great benefit. Some kinds of graſs-plants may require a greater proportion of water than ordinary to promote their vegetation, and may receive benefit from this practice. Clear water, eſpecially if it comes immediately from ſprings, can ſcarcely have any other effect. It muſt be acknowledged, however, that if water runs along a bed of marle, or chalk, or lime-ſtone, it will acquire ſome of their qualities; and, if let upon land, will operate in the ſame manner with theſe manures *.

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* Lime-ſtone has the ſame qualities with lime; it attracts and ferments with acids, and produces ſalt.

CHAP.

CHAP. XVI.

Of compound dunghills.

THE ordinary dunghills belonging to a farm, may be called *compound dunghills*. They are made up of the dung of different animals, of different kinds of ſtraw, and other vegetable ſubſtances; and they have frequently different animal ſubſtances in their compoſition.

THE dunghills which we propoſe here to treat of, are of a different kind, made up of earth, mixed with dung from an ordinary dunghill, lime, and other manures.

SOME perſons make dunghills of this kind, and are of opinion, that the dung and other manures, with which they are compounded, are thereby made to enrich a greater quantity of land, than if not mixed with earth; and, beſides, do not produce the bad effects which ſometimes are produced by dung, when taken directly from a dunghill, and laid upon land.

It will not be amiſs, that we inquire into the advantages of this kind of dunghills; which will be a means not only of recommending them, but alſo of pointing out the moſt proper method of conſtructing them.

The firſt thing to be inquired into, is, the advantage ariſing from the mixing lime, marle, or other manures, with the earth and dung. Lime, as it is a diſſolver of all vegetable and animal ſubſtances, when mixed with dung, will help to diſſolve it; and as it communicates an abſorbent power to earth, will enable the earth with which it is mixed to attract the vegetable food in greater plenty from the air. But, in order to make it produce theſe effects, it is neceſſary to mix it with the dung and earth. For, if the lime is laid in a kind of *ſtratum*, above the dung, and below the earth, it will abſorb the water that falls upon the dunghill, and thereby will prevent the dung from receiving a ſufficient quantity of water to make it putrefy; and will alſo occaſion ſuch a heat, as to burn the dung, and render it uſeleſs *; and, beſides, can have but little influence in diſſolving the dung, and communicating to the earth its abſorbent quality. If the lime is laid above the earth, and expoſed to the air, it will be attended with the ſame conſequences, it will abſorb the water; and though it will attract the vegetable food from the air, yet will be of no more uſe, for this end, than if ſpread upon as much land as the ſurface of the dunghill extends to.

The ſame thing may be ſaid of marle, if uſed inſtead of lime. But, if marle is uſed inſtead of earth, it is probable that the compoſt will become very rich, as the marle has a very ſtrong abſorbent quality, and would be greatly expoſed to the in-

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* See chap. 5. of this book.

fluence of the air. A much ſmaller quantity than is uſed in the ordinary way, it is probable, would be found ſufficient, and its effects would be ſooner diſcovered. If this is tried, it will be neceſſary to carry the dung to the marle-pit, and there form the dunghill. For marle is ſo heavy a body, that it would be too expenſive to carry it firſt to the dunghill, and then to the field.

THE advantage of mixing dung with the earth is next to be conſidered. This, it is probable, is the principal advantage of the compound dunghills, and that the advantages ariſing from lime are but trifling. They are often made without lime, and their effects, 'tis ſaid, are equally good.

DUNG, in the ordinary dunghills, has its vegetable food ſometimes waſhed away by rain, when it falls in large quantities. Now, this is prevented by the earth in the compound dunghill, which abſorbs the water, and all the vegetable food which it carries from the dung.

In the ordinary dunghills, the dung on the ſurface, it is generally ſuppoſed, loſes a part of its vegetable food, which is exhaled by the ſun, or carried off by the wind. This is prevented by covering the dung with earth in the compound dunghill.

But it is probable, that the compound dunghill receives its principal advantage from the earth being expoſed to the influence of the air: and, if this is true, the more abſorbent that the earth is which is uſed, and the larger that the ſurface of the dunghill is, in proportion to its bulk and the quantity of dung contained, it will be the richer.

This directs us to the proper method of conſtructing it, to make it long and narrow, with as many diviſions in it as can be made conveniently. For thereby a larger ſurface is expoſed in the ſame quantity, and the more vegetable food acquired.

IT is proper to obſerve further, that earth ſhould always be in the bottom of the dunghill, to receive any of the juices of the dung which the rain may carry downward; that the dung ſhould be immediately covered with earth, to prevent the juices from being exhaled, or carried off; and that the earth ſhould be expoſed for a conſiderable time, before any more dung is laid on, that ſo it may receive all the benefit from the air which it is capable of, before it is covered.

THIS kind of dunghills is made with leaſt expenſe upon the field for which the dung is intended. The head ridges are commonly high raiſed, by the turning of the ploughs upon them, and contain the richeſt earth in the field. Theſe are very proper places for the dunghills. The earth is at hand, and can eaſily be thrown upon the dung.

Those that treat of dunghills of this kind, commonly recommend earth as oppoſite as poſſible to the nature of the ſoil upon which the dung is to be laid. They recommend clay for a light ſoil, and light earth for a clay ſoil. But theſe the farmer cannot always command; and, beſides, though he can, will frequently find it very expenſive to carry them. It is probable, that there is not ſo much in adapting the earth of the dunghill to the kind of ſoil, as perſons at firſt ſight are apt to imagine. It is certain, that there cannot be ſo much in it as to anſwer the expenſe of leading earth. 'Tis true, that, in many farms, there are different ſoils, and, therefore, the dung may be carried to a ſoil different from the ſoil of the field for which it is intended; there the dunghill may be formed, and from thence carried to the field. But ſtill this is an additional trouble and expenſe; and therefore this method is not to be followed, till, upon a comparative trial, the advantages are found to do more than anſwer the expenſe.

IT is a practice in ſome parts of Scotland, to lay clay upon clay land *. This practice, it is ſaid, ſucceeds very well; which makes it probable that it is not very material what kind of earth is uſed for the compound dunghill, provided it is of the abſorbent kind: and, therefore, the farmer need not be anxious about getting earth different from his ſoil, but may make his compound dunghill of the earth of the field which he intends to manure.

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* THE ſoil of the carſe lands, upon the river Forth, is a very ſtiff clay, and yet it is a general practice among the farmers of thoſe lands to dig clay in the ſummer ſeaſon, and mix with dung. This, they ſay, turns to a very good account. It is probable, therefore, that there is not much depends upon the kind of earth uſed in the compound dunghills; and that the principal advantage of thoſe dunghills is the expoſing the earth to the influence of the air. However, if the farmers that follow this practice could be prevailed upon to try the earth of a head ridge, inſtead of digging clay, their work would be done with much leſs trouble, and at much leſs expenſe; and the dunghill, it is probable, would be as rich.

CHAP.

CHAP. XVII.

Of ſuch manures as cannot be obtained in large quantities.

BESIDES the manures already treated of, there are a variety of other things that greatly promote vegetation; the different parts of animals, ſuch as hair, wool, horn, ſkins, *&c.*; alſo parts of plants, ſuch as ſaw-duſt, malt-duſt, rotten wood, bark, *&c.* Theſe are all good manures. They promote vegetation in the ſame way as dung; and their operations are ſlow or ſudden, as they diſſolve with greater or leſs difficulty. They may be uſed in all kinds of ſoil, as they contain vegetable food; and any kind of manures may be applied to land after their operation is over.

THOUGH they cannot be obtained in ſuch large quantities, as to be uſed by themſelves; yet they ought not to be thrown away, but mixed with the dung in the dunghill. All of them, the animal manures in particular, will not only add to the vegetable food in the dunghill, but alſo greatly promote its putrefaction.

BOOK IV.

Of Soils.

CHAP. I.

Of the deſign.

IT has already been obſerved, that plants find their food in the earth. It has likewiſe been obſerved, that the vegetable food in the earth is increaſed by tillage, and by manures.

IT is obvious, that ſoils very different in their natures, are fit for nouriſhing plants. It has been ſhown, that manures are alſo very different in their natures and operations. To apply theſe, then, in ſuch a manner as moſt effectually to promote vegetation, it is of importance to know the nature of the different ſoils, and wherein their difference conſiſts.

To inquire into theſe things, is the deſign of this book.

CHAP. II.

Of the diviſion of ſoils, with reſpect to manures.

IT has already been obſerved, that ſoils are very different in their natures, and compounded of very different ingredients. It has alſo been obſerved, that the food of plants is compounded of different ingredients, and that manures afford theſe different ingredients in different proportions. Now, it is natural to ſuppoſe, that ſoils differ ſo much in their natures from each other, that ſome contain a greater proportion of ſome of the ingredients of the vegetable food, and that others contain a greater proportion of other ingredients. It is neceſſary, therefore, to conſider the different kinds of ſoils ſeparately, and to inquire wherein their difference conſiſts; that ſo it may be known what kind of manures are moſt proper for them.

Soils have already been divided into ſuch kinds as require a different management with reſpect to tillage; they are now to be divided into ſuch kinds as require a different management with reſpect to the application of manures.

The ſoils moſt common in Scotland are theſe following: The black loamy ſoil, the clay, the ſandy, and the moſſy. Of all theſe there are great varieties, ariſing from the different proportions of that kind of earth from which they take their names; as alſo from a mixture of theſe kinds of earth with each other. It is difficult to determine to what claſs ſome ſoils belong, as it is difficult to know what kind of earth prevails moſt in them.

CHAP. III.

Of the black loamy ſoil.

LOAM, it is probable, is not an original ſoil, but the earth of rotten vegetables.

IF land has continued long uncultivated, and has carried vegetables, which from time to time have rotted upon it, the original ſoil is buried, and a new ſoil made up of the earth of rotten vegetables formed. This new ſoil, formed by the rotting of vegetables, is what is commonly called *loam*. And it is probable, that all loamy ſoils have been formed in this way, or by the repeated application of dung, the earth of which, as was before obſerved, is of the ſame kind with the earth of rotten vegetables.

THE qualities of loam are as follow.

WHEN allowed to reſt, its parts acquire a degree of coheſion. In this it differs from ſand, and has a reſemblance to clay, but never becomes ſo tough and hard.

When turned up and expoſed to the air, it breaks eaſily in pieces, and becomes free and open. In this it differs from clay, and has a reſemblance to ſand, but does not ſeparate into ſuch ſmall particles [*].

When dry it receives water eaſily. In this alſo it differs from clay, and has a reſemblance to ſand.

When it receives the water, it ſwells with it, and retains it like ſhell marle. In this it differs from ſand, and has a reſemblance to clay, but ſwells more, and does not retain ſuch a quantity [†].

When a large quantity of water falls

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[*] Loam may be ſeparated into more minute particles than ſand, but the air muſt act upon it for a conſiderable time before this is done.

[†] It is obſerved, that in this, and in all ſpungy ſoils, the crowns of the ridges, though high raiſed, are never quite dry, while water ſtagnates in the furrows.

upon this ſoil, it retains a proper ſhare of it, and allows the reſt eaſily to run off. In this again it differs from clay, and has a reſemblance to ſand *.

CHYMISTS tell us, that it contains oil †, and has the power of attracting and fermenting with acids.

LOAM then, in ſome reſpects, is a medium between clay and ſand.

IT acquires a degree of firmneſs greater than ſand; it is not ſo eaſily broken in

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[*] THERE are other ſoils that have the ſame quality with this; they receive water eaſily, ſwell with and retain it: but this ſoil has greatly the advantage in this reſpect, that it retains only a proper quantity, and allows the ſuperfluity eaſily to run off, when there is a proper deſcent; whereas the other ſpungy ſoils retain, though there is a deſcent, a larger quantity than is neceſſary for nouriſhing the plants which we cultivate in our fields.

[†] THIS oil found in the loamy ſoil, is an evidence of its ſtrong attractive power. It cannot be ſuppoſed to belong originally to the ſoil, but is attracted from the air. If the ſoil did not receive a conſtant ſupply from the air, the oil would ſoon be exhauſted by the crops which it carries.

pieces; it does not ſo eaſily admit water, and it does not ſo eaſily part with it.

It does not acquire ſuch a degree of firmneſs as clay; it is more eaſily broken in pieces; it more eaſily admits water, and it more eaſily parts with it.

But in ſome reſpects it differs from both. It has a ſtrong abſorbent quality; it contains oil, and it attracts and ferments with acids.

The ſoil which has loam in its compoſition, poſſeſſes in ſome degree the qualities of loam: and if theſe qualities are conſidered, it will appear, that this kind of ſoil is the moſt proper for nouriſhing plants.

It has plenty of food; the power of attracting this food from the air; a large paſture, and the power of diſſolving the vegetable food, and fitting it for entering the roots of plants.

The oils which it contains, and ſalts which it produces, afford vegetable food; the ſalts which it produces, and the ſtrong abſorbent quality which it poſſeſſes, attract this food from the air: its free and open nature, its ſwelling with water, and its fermenting with acids, afford a large paſture; and the ſalt which it produces by fermenting with acids, diſſolves its oils, and fits them for entering the roots of plants. This is confirmed by experience. The ſoil compounded of loam, is found to be the moſt fruitful of all others. Some other ſoils, when manured with lime or dung, bear as great, perhaps greater crops for ſome years than this does, but then they ſooner need a ſupply. The difference between them ſeems to conſiſt in theſe things. Soil manured with lime has a greater proportion of ſalts than of oils in its compoſition, and has alſo a greater power of forming ſalts than of attracting oils; and therefore, by the great crops it bears, its oils will be wholly exhauſted, and it will become almoſt quite barren: whereas the loamy ſoil, having an equal proportion of oils and of ſalts in its compoſition, and as great a power of attracting oils as of forming ſalts, will not be exhauſted by the crops which it bears; but will always retain a quantity of its oils undiſſolved, and be receiving a conſtant ſupply from the air. The ſoil manured with dung has greater plenty of vegetable food in its compoſition than it has the power of attracting this food from the air, and therefore, by every crop that carries off more vegetable food than is attracted during the ſeaſon, the ſoil muſt be rendered leſs fertile; whereas the loamy ſoil has the power of attracting the vegetable food from the air, almoſt in proportion to the quantity it contains, and therefore continues to be fertile notwithſtanding the crops which it bears. It is obſerved, that ſome kinds of this ſoil, which have a great proportion of loam, and are, in a great meaſure, free from clay and ſand, continue to carry good crops, without being in the leaſt exhauſted. This is owing to their great abſorbent quality, to their attracting, during the winter, from the air ſuch a quantity of vegetable food as is ſufficient for nouriſhing the crop during the ſummer.

It has been obſerved, that loam receives water eaſily, and retains it, and that it alſo eaſily parts with water when in too great a quantity. The loamy ſoil therefore cannot ſuffer much either from drought or rain, unleſs they are violent. This is confirmed by experience: for it is found that the loamy ſoil does not ſuffer ſo much from drought as the ſandy, and does not ſuffer ſo much either from drought or rain as the clay.

All ſoils, in proportion to the quantities of dung that have from time to time been laid upon them, approach the nearer to this kind; for the earth into which animals, vegetables, and dung are turned, after they are wholly putrefied, is of the abſorbent kind, and of the ſame nature with this ſoil. And though there is but a ſmall quantity of earth in the largeſt quantity of dung laid on at one time; yet, if the laying on of the ſame quantity is repeated once in four or five years for ſome ages, as certainly has been done upon ſome lands, a conſiderable proportion of the ſoil muſt now be of this abſorbent earth, whatever it was originally. All land called *infield land*, has a mixture of this kind of ſoil in its compoſition; and the difference betwixt infield and outfield is owing to the quantities of dung laid from time to time on the infield.

The ſoil in which there is a great proportion of loam, needs very little manure. It may be kept conſtantly in good heart by proper tillage, and a good ſcheme of management. There is however but a ſmall quantity of this kind. The generality of that which goes under the name of loamy ſoil requires manure, and no kind of manure is improper for it. Dung, ſoot, ſea-weed, vegetables, and the other manures of this kind, add to its vegetable food; and lime, aſhes, and marles find vegetable food to work upon. But as this kind of ſoil has the vegetable food, and the power of diſſolving it in juſt proportions, dung, and the other manures which continue there in their juſt proportions, are certainly the moſt proper. When lime is applied, if care is not taken, it will ſoon rob this ſoil of its oils: for as this ſoil has in itſelf a power of attracting and fermenting with acids, lime, which adds to this power, will ſooner rob it of its oils than other ſoils that have not this power.

A LATE writer obſerves of this ſoil, that it has an agreeable ſmell; which, he ſays, is probably owing to the volatile ſalts and oils flying off by fermentation. This is inconſiſtent with that abſorbent quality, which, in treating of this ſoil, we have obſerved that it is poſſeſſed of; and which the ſame author allows to it in a very high degree. If theſe ſalts and oils actually fly off from it in ſuch quantities, as to make us ſenſible of them by ſmell, it is natural to think, that the ſoil by ploughings would rather loſe than acquire vegetable food; the reverſe of which we know to be true from experience.

CHAP.

CHAP. IV.

Of the clay ſoil.

THERE are different kinds of clay ſoils. The richeſt kind conſiſts of clay and loam. Probably it has been originally clay, and by the application of dung, or the rotting of vegetables that have from time to time grown upon it, has received the mixture of loam.

To know the nature of this ſoil, it is neceſſary to conſider the qualities of clay, which are as follow.

CLAY is a very ſolid body, its parts adhere very firmly together. It does not eaſily admit water; it is capable of receiving a large quantity: when it receives water, it ſwells but little, and does not eaſily part with it.

IN theſe reſpects it differs from loam and ſand. For their parts do not adhere together with firmneſs; they eaſily admit water, and they eaſily part with it: ſand eaſily parts with a very ſmall quantity.

CLAY, when dry, is very hard; and the more ſuddenly it is dried, it becomes the harder. It contracts in drying, but not equally in all its parts; where the coheſion is weakeſt, it opens in rents.

CHYMISTS ſay, that clay does not ferment with acids, but that it has oil in its compoſition. This however does not appear quite certain.

SOIL in which there is a mixture of clay, muſt partake in ſome degree of its qualities. When theſe are conſidered, it will appear, that this ſoil is not ſo proper for nouriſhing plants as the loamy ſoil. It is much expoſed to injuries from the weather, and muſt ſuffer greatly from exceſſive drought or rain.

As it is capable of receiving a great

quantity of water, and does not eaſily part with it, if the ſeaſon is rainy, the roots of plants will be continually ſoaked in water, and thereby the plants themſelves weakened or deſtroyed.

As it turns hard when dry in a great drought, the pores of the ſoil will be ſhut, the paſture leſſened, and the plants unable to ſearch for their food. As, in contracting by drought, it opens in rents, thereby ſome of the roots will be torn aſunder, and expoſed ſo much to the air, as to endanger the deſtruction of the plants.

Experience confirms the truth of theſe things. For it is obſerved, that clay ſoils are actually more uncertain than loamy ſoils, and the crops upon them more precarious, more eaſily damaged by drought or rain.

As clay does not eaſily receive water; dews and ſoft ſhowers of rain, which are ſucked in by the loamy ſoil and retained, make no impreſſion on the clay ſoil; but, being reſiſted by the ſurface, are ſoon exhaled by the ſun. It is obſerved ſometimes, that when the plants both upon the clay and loamy ſoils are beginning to ſuffer from the violence of the drought, ſoft ſhowers, being eaſily admitted by the loamy ſoils, recover the plants upon them, while the plants upon the clay ſoils, which reſiſt theſe ſhowers, receive no benefit.

It muſt be allowed, however, that it is not in every circumſtance, that the crop upon the clay ſoil is more damaged by drought than the crop upon the loamy ſoil. If the drought ſets in immediately after the land has got the ſeed-furrow, the clay ſoil is apt to dry ſo ſuddenly, and turn ſo hard, that a great part of the ſeed ſown is prevented from ſpringing up, and the plants that are growing do not find ſufficient food. On the other hand, if the drought does not ſet in immediately after the ploughing, but the ſoil allowed to continue ſoft, and ſufficient ſap allowed to remain, for making the whole ſeed vegetate or ſpring up; then though the drought ſhould afterwards be very violent, yet the ſoil, being covered with the young plants, will not dry ſo ſuddenly, nor turn ſo hard as to prevent them from finding their food. The ſoil having dried ſlowly, and in drying been frequently moiſtened with ſhowers, will only cruſt a little above, and thereby prevent the drought from penetrating. In this caſe, when the drought does not ſet in early, plants will flouriſh on the clay ſoils, even when they are ſuffering upon the loamy ſoils, by reaſon of the violence of the drought.

It muſt be obſerved likewiſe, that clay land, when dry ſituated, does not ſuffer ſo much from drought as when wet. When clay land is wet ſituated, having a greater degree of wetneſs when the dry ſeaſon begins than the dry-ſituated land, it will on that account dry more ſuddenly. Beſides, even in the dry ſeaſon, it is generally too wet; and in this condition being ploughed, it muſt dry much faſter in the ſame time than dry-ſituated land either before or after ploughing, and thereby becomes much harder. This has been mentioned to ſhow, that all clay lands do not ſuffer equally from drought; that ſuch as are dry ſituated, ſuffer little more from it than loamy ſoils; and that they do not ſuffer ſo much, either from rain or drought, as thoſe that are wet ſituated.

It will not be improper to obſerve from this, that it is of the utmoſt importance to manage clay land in ſuch a manner, as to keep it as dry as poſſible during the winter. For thereby it is not only in a condition for being ploughed more eaſily in the ſpring, but the crop upon it is alſo in leſs danger of ſuffering either from rain or drought.

It has been obſerved, that clay contains oil, but does not ferment with acids. It would ſeem, then, that the clay ſoil has the vegetable food in greater plenty than it has the power of diſſolving it; and therefore that lime, aſhes, or marle are the moſt proper manures for it. Theſe manures will ſeparate and diſſolve its oils, and render them fit for entering the roots of plants. They will likewiſe communicate to it their abſorbent qualities, will open its pores, and enlarge its paſture. Theſe things will make it more eaſily to admit the water, and more eaſily to part with it; by which it will become leſs expoſed to injuries from the weather, from violent rains, or drought.

It was the general opinion ſome time ago, that lime anſwered better on light land than on clay. This is inconſiſtent with what has been advanced. The foundation for this general obſervation probably is this: Clay ſoils are generally much wetter than light ſoils; and as the virtues of lime are extracted by water, thereby its powers muſt be greatly leſſened upon the generality of clay ſoils. That it is owing to this that lime does not anſwer upon ſome clay ſoils, is moſt probable: for, upon trial, its effects are found to be very great upon clays that are but tolerably dry ſituated.

It was alſo the general opinion ſome time ago, that marle was only proper for light land; but the contrary is now, upon trial, found to be true. Its effects on clay land continue much longer than on light land.

It is no objection to what is here propoſed as the beſt manures for clay ſoils, that dung anſwers very well on them: for dung, as it contains every thing proper for promoting vegetation, muſt anſwer on all ſoils.

Clay ſoils, though they partake of the nature of clay, yet, from the other ingredients in their compoſition, are very different from each other. When mixed with loam, as has already been obſerved, they are rich; but when mixed with ſand or till, are very poor. Lime, marle, or aſhes, as has been obſerved, are very proper manures for rich clays. But the poor clays require ſuch manures as contain the greateſt plenty of the vegetable food, ſuch as dung, ſhell-marle, ſea-weed, *&c.* But theſe, ſhell-marle excepted, do not operate ſtrongly in enlarging the vegetable paſture, nor in communicating to the earth a ſtrong abſorbent quality, which, we have already obſerved, are neceſſary qualities in the manures moſt proper for all clay ſoils. Shell-marle is poſſeſſed of theſe qualities, and is therefore a proper manure for poor as well as rich clays. But if it cannot be obtained, a mixture of lime and dung, or of dung and marle, will ſerve in its place.

It is an ordinary practice in ſome places, to lay both dung and lime upon fallow-land, even when the ſoil is naturally good; and the applying theſe together is found to anſwer better, than applying one of them only, though in a greater quantity. There is good reaſon to ſuppoſe, that the applying theſe together upon poor clays will be attended ſtill with greater advantages.

We have obſerved, that, when clay is mixed with ſand, it is generally very poor: and yet ſome writers propoſe ſand as the moſt proper manure for clay. They aſſure us, that nothing more is neceſſary to give it all the qualities of rich loam, than to apply ſand in a ſufficient quantity *. This, I am perſuaded, is aſſerting too much, and what they have not ſufficient experiments to juſtify, notwithſtanding their aſſertions. Let a perſon take a quantity of clay and ſand; let him, if he pleaſes, dry them, and pound them in a mortar; yet he will never make loam of them. He may poſſibly produce a ſoil that will retain water better than ſand, and will

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* See Bradley's treatiſe, vol. 3. Aug. p. 55. 56. He recommends laying ſandy or gravelly ſoil upon clay, four inches thick. See likewiſe, *New ſyſtem of agriculture, p.* 124. a ſtory related of a gentleman, who mixed a field of hard brown clay with a field of very burning gravel, by which the ſoil of both fields was *converted into a good hazel mould, and produced a plump round grain, and as plentiful harveſts as any ſoil in the kingdom.*

more eaſily part with it than clay; but it will never poſſeſs that abſorbent quality, that power of attracting and fermenting with acids, by which loam is particularly diſtinguiſhed. Dr Home expreſſes a doubt, whether the mixture of clay and ſand will even have the qualities mentioned. He ſeems to think, that a little ſand rather increaſes the union of the particles of clay. This he infers from the cuſtom of uſing ſand in the manufacture of brick. But he has no reaſon to infer this from his own experiment. For, according to the account he gives of it, the plants of barley in the pot with the mixture of clay and ſand, were not ſo bad as thoſe in the pot filled with pure clay. However, we may ſafely infer from this experiment, that the advantages of mixing ſand with clay ſhould appear more evident, than the aſſertion of ſome writers on agriculture makes them, before a farmer puts himſelf to the expenſe of mixing them together in his fields.

CHAP.

CHAP. V.

Of the ſandy ſoil.

THERE are ſeveral kinds of ſandy ſoils. The beſt kind is a mixture of ſand and loam. Sand itſelf is of two different kinds. The one conſiſts of ſmall particles of flint, the other conſiſts of ſmall broken ſhells. Often theſe two are mixed together, which may be called a third ſort.

THE qualities of ſand of flint are as follow.

IT eaſily receives water, and it eaſily parts with it. Rain makes it firmer, and leſs in bulk. The particles of it do not adhere together; and it is ſuſceptible of greater heat from the ſun, than any thing of which other ſoils are compounded.

IT appears, then, that the qualities of this kind of ſand are directly oppoſite to thoſe of clay.

The ſand of ſhells has nearly the ſame qualities with theſe mentioned; but differs from the other in theſe things following.

The ſand of ſhells, like ſhell-marle, attracts and ferments with acids, is capable of being diſſolved, and contains oil [*]; whereas the ſand of flint does not attract acids; the particles of it, like the firſt atoms, are incapable of diſſolution, and, if it contains any oils, it is impoſſible to ſeparate them.

Soil which has a large proportion of ſand in its compoſition, muſt, in ſome meaſure, partake of the nature of ſand. And, if this is conſidered, it will appear, that the ſandy ſoil is ſtill more unfit for nouriſhing plants than the clay ſoil.

As it eaſily parts with water, there will not be a ſufficient quantity, in a dry ſeaſon, to promote vegetation.

As the particles of it do not adhere together,

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[*] See book 3. chap. 13.

gether, it will not be able to ſupport vegetables that have but few roots, and grow tall.

It may be obſerved, particularly with reſpect to the ſoil compounded of ſand of flint, that, as it contains no oils, it muſt have but little vegetable food; and, as it has no abſorbent quality, it will receive but a ſmall ſupply from the air. And it may be obſerved, particularly with reſpect to the ſoil compounded of ſand of ſhells, that, as the ſhells contain oil, and as they diſſolve gradually, though ſlowly, it has naturally a larger quantity of vegetable food than the other; and, as it attracts and ferments with acids, it receives alſo a greater ſupply from the air.

The defects of the ſandy ſoil point out the manures moſt proper for it.

The manures moſt proper for the ſoil compounded of ſand of flint, are ſuch as make it retain water, render it firmer, and ſupply it with vegetable food. Clay will help to make it retain water, and make it firmer; but clay contains but little vegetable food. Dung will ſupply it with vegetable food, but will not render it firmer, nor make it retain water. Moſs will help it to retain water, and ſupply it with vegetable food, but will not make it firmer *. A mixture of clay and dung, or of clay and moſs, ſeems to be the moſt proper manure, and beſt fitted for ſupplying its wants.

A MIXTURE of either of theſe will alſo be a proper manure for ſoil compounded of ſand of ſhells. But if any thing could be found out that would quickly reduce ſhells to a ſtate of corruption, which ſeems to be the condition of ſhell-marle, that thing would certainly be the moſt proper manure for this kind of ſoil.

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* See next chapter. Dr Home is of opinion, that moſs alone is the moſt proper manure for ſand. He ſays that moſs is as impervious to water as clay, and contains more oil than any other vegetable. He adds, that it has been tried, and is found to anſwer very well. But it may be obſerved, that moſs cannot render ſand any firmer, and therefore will not enable it to ſupport a great crop of corn.

The authors of the Complete body of huſbandry mention a field of ſand manured with clay, which had retained its fertility for thirty years; and, in their opinion, would hold good ten or twelve years more. That laying clay upon a ſandy ſoil, and ſand upon a clay ſoil, will do ſervice, is very probable; but that it will anſwer the expenſe, is uncertain. The farmer muſt, therefore, be on his guard, leſt he be led into a fruitleſs expenſe by authors, whoſe aſſertions are more frequently founded upon common report than their own experience.

CHAP. VI.

Of the moſſy ſoil.

MOSS is commonly ranked in the claſs of vegetables. It is not very certain whether the vegetables are alive or dead. That kind of moſs of which peat is made, is probably vegetables in a living ſtate; but that kind that is free and open, is certainly the roots, and other parts of dead vegetables in an uncorrupted ſtate. The kind of moſs moſt common has very little firmneſs, either when wet or dry, and, it is obvious, is not alive.

The qualities of moſs are as follow.

It has oil and ſalt in its compoſition, as all vegetables have. It does not eaſily putrefy, and it prevents other bodies from putrefaction. It eaſily receives water, ſwells with it like a ſpunge, retains a large quantity, and does not eaſily part with it.

As moſs, whether dead or alive, is in an uncorrupted ſtate, to render the moſſy ſoil fit for nouriſhing vegetables, the moſs in it muſt be reduced to putrefaction. This will not only ſupply it with plenty of vegetable food, but will alſo render it much firmer, and make it more eaſily to part with water.

The manures that ferment moſt violently with acids, ſeem to be the moſt proper for this end.

These manures, aſſiſted by frequent ploughings, will certainly make ſome parts of the moſs putrefy.

Of all theſe the clay and ſtone marles ſeem to be the moſt proper; becauſe theſe will not only raiſe a violent fermentation, but will alſo fill up its pores, and make it more ſolid, by which it is rendered more proper for reſiſting the entrance of water.

It is neceſſary to obſerve, that if the moſs is deep, or has not a ſolid bottom, lime is not proper; becauſe, by its weight, it will ſoon penetrate beyond the reach of the plough. The marle will alſo do this, but not ſo ſuddenly as lime; but if the moſs has a ſolid bottom to reſiſt the lime, this manure will anſwer very well. Beſides its other qualities, it has a power of diſſolving animal and vegetable ſubſtances. This is confirmed by experience. Lime is found to improve this kind of land ſo much, that in ſome places where the land is not originally worth half a crown of yearly rent *per* acre, it is laid on at the expenſe of ſix pounds *Sterling per* acre; ſo that the laying on the lime to anſwer the expenſe, muſt raiſe it to four times its original value.

When any manures are applied to moſs, the fermentation will be violent, and it will continue while the moſs is putrefying. During this time it cannot be proper for nouriſhing vegetables. The violence of the fermentation will throw the ſeeds, and ſometimes the roots out of the ground *; and even when putrefied, being very looſe and open, will greatly encourage the growth of creeping weeds. It ſeems proper therefore to allow it a conſiderable time to ferment after the manure is laid on, before any ſeed is ſown; and to deſtroy theſe weeds, ſo apt to grow upon it, frequent harrowings, as well as ploughings ſeem neceſſary.

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* There are ſome kinds of ſoil that frequently do this, particularly after froſt, which muſt be owing to their fermentation. When a ſoil does this frequently, it is almoſt a certain mark that there is moſs in its compoſition.

It is commonly obſerved, that the frequent ploughing of this ſoil makes it run much to chickenwort, and other creeping weeds, by which the crop is often deſtroyed. And hence it is become almoſt a general practice to plough it but ſeldom, which is found to anſwer better. But if this ſoil was fallowed for two ſeaſons, and frequently ploughed and harrowed each ſeaſon, it is natural to think that the putrefaction of the ſoil would be promoted, weeds deſtroyed, and the ſoil in a much properer ſituation for nouriſhing vegetables than when it receives only a few ploughings.

FINIS.